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THE FIELD PRACTICE

75

RICHARD C. CRIDGE
and Surveyor
VICTORIA, B.C.

LAYING OUT CIRCULAR CURVES

FOR

RAILROADS.

BY JOHN C. TRAUTWINE, C.E.,
OF THE UNITED STATES.

Extracted, and sold separately, from Simms's work on Levelling,
being pp. 139—215.

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1856.

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PREFACE.

This little volume has been prepared almost entirely with reference to the wants of young men who desire to qualify themselves for field service in an Engineer Corps. On that account the plainest language has been used to render the subject intelligible,—dispensing with mathematical brevity.

The Table of Natural Sines and Tangents to single minutes, in a form sufficiently portable for field use, will supply a want which is frequently experienced, not only in the operation of laying out curves, but on many other occasions.

One object in preparing it, was to furnish the profession with a Table that should be not only portable, but *absolutely reliable*. Those whose occupations compel them to resort to the Tables in common use, must have frequently experienced the embarrassment which attends the inaccuracies to which they are all subject. So long as a Table is known to contain a single error, the position of which is not ascertained, its employment is attended with doubt in every instance in which we are obliged to refer to it.

As Hutton's Tables of Natural Sines and Tangents are those most in use among the profession, it will be desirable to those persons who possess them, to be able to correct the following errors, which I detected in comparing them.

In Hutton's Tables, Fifth Edition, 1811.

Sine of 6° 8′, for ·1063425, read ·1068425.
Page 328, at top, for 25 Deg., read 40 Deg.
Tangent of 44° 60′, for ·1000000, read 1·000000.
Tangent of 41° 60′, for ·8994040, read ·9004040.

PREFACE.

In Dr. Gregory's corrected Edition (the 8*th) of Hutton's Tables,* 1838.

Sine of 49° 14′, for ·7576751, read ·7573751.

In Hassler's Tables, 1830.

Sine of 78° 24′, read ·9795752.
Sine of 20° 60′, „ ·3583679.
Sine of 66° 19′, „ ·9157795.
Sine of 56° 39′, „ ·8353279.
Sine of 55° 20′, „ ·8224751.
Sine of 53° 4′, „ ·7993352.
Sine of 48° 12′, „ ·7454760.
Sine of 45° 3′, „ ·7077236.

The discrepancies of 1 in the 7th decimal, are not considered as errors, as they are occasioned by a neglect of the value of the 8th decimal. For calculating curves, it is not necessary to use more than 4 decimals.

It is scarcely necessary to remark that, beyond 44°, the Sines, Tangents, &c., are read *upwards*, from the bottom of the page, using the corresponding column of minutes. To find the sine of an angle exceeding 90°, subtract the angle from 180°, and take out the sine of the remainder—because the sine of an angle, and that of what it wants of 180°, are the same.

J. C. T.

RICHARD C. CRI
SURVEYOR
VICTORIA B.C.

THE FIELD PRACTICE
OF
LAYING OUT CIRCULAR CURVES
FOR
RAILROADS.

ARTICLE I.

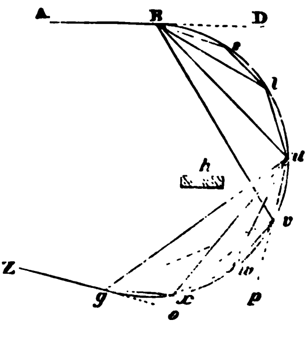
PRINCIPLES OF LAYING OUT CURVES.

METHOD 1.

To lay out a Curve by means of Tangential Angles.

If from any point B, fig. 1, in a straight line A D, we lay off any number of equal angles, as D B *s*, *s* B *t*, *t* B *u*, *u* B *v*, &c., and at the same time make the chords B *s*, *s t*, *t u*, *u v*, &c., equal to each other, then the points B, *s*, *t*, *u*, *v*, &c., will be situated in the circumference of a circle, which is tangential to the line A D at the point B.

Fig. 1.



The first of these angles, D B *s*, is called the *tangential angle*, as being that by which the curve is connected with the tangent A D; but inasmuch as the others are all equal to it, they also are called tangential angles.

If any obstacle, as *h*, should prevent our seeing from B farther than to *v*, the curve may be continued by removing the instrument to *u*, the point preceding *v:* thence sighting first on *v*, continue to lay off additional tangential angles *v u w*, *w u x*, &c., as before. Or else, moving the instrument to *v* itself instead of to *u*, sight back to *u*, and lay off first the exterior angle *p v w*, equal to *double* the tangential angle, and afterward continue the tangential angles *w v x*, *x v g*, &c., as before, to the end of the curve.

Finally, in order to pass from the end of the curve at *g*, on to a tangent *g z*, place the instrument at *g*, and sighting back to *x*, lay off the tangential angle *x g o;* then *o g* continued toward *z* will be the required tangent. (See Art. IV.)

For the tangential angles corresponding to different radii, and chords of 100 feet, see page 160.

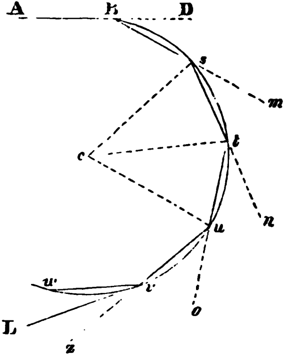
ARTICLE II.

METHOD 2.

To lay out a Curve by means of Deflection Angles.

Fig. 2. First, having, as in method 1, laid off a tangential angle D B *s*, and measured the chord B *s*, remove the instrument to the end *s* of the chord, and make the exterior angle *m s t* equal to *twice* the tangential angle, and measure the chord *s t;* and so on at the other points *t, u, v,* &c., making each of the exterior angles *n t u, o u v,* equal to twice the tangential angle, and all the chords equal; then will the points B, *s, t, u, v,* &c., be in the circumference of a circle which is tangential to the line A D at the point B, as by the first method.

Fig. 2.



But if, at any of these points, as *v*, we wish to pass off to a tangent *v* L, employ at that point the ***tangential*** angle *z v* L, equal to half the deflection angle *z v w*. (See Art. IV.)

These exterior angles, included between any *chord* and the extension of the preceding *chord,* are called *deflection angles,* or *angles of deflection,* or *angles of curvature.* In any given circle, the angle of deflection is always precisely double the tangential angle, supposing the chords to be equal. At page 160, we give tables of the angles corresponding to circles of different radii, embracing the limits of railroad practice; and calculated for chords 100 feet in length, that being the usual length for a measuring chain on public works.

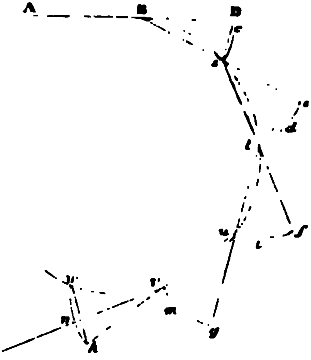
N.B. The deflection angle of any curve is equal to the angle *t c u*, or *t c s*, &c., at the centre of the circle, subtended by one of the equal hords *t u* or *t s*. This angle at the centre, so subtended, is called the *tral* angle. The tangential angle, being always half the deflection le, is, of course, always half the central angle.

ARTICLE III.

METHOD 3.

To lay out a Curve by Eye.

Fig. 3.



The *deflection* angles, fig. 3, *e s t, f t u, g u v, h v w*, &c., being double, the *tangential* angle D B *s*, the *arcs e d t, f i u, g m v, h n w*, &c., are double the *arc* D *c s*, since the arcs of circles are proportionate to the angles which they subtend; but the *chords e t, f u, g v, h w*, &c., are *not* double the *chord* D *s*, since the chords of arcs are not proportionate to the arcs, or to the angles which they subtend.

The chords *e t, f u, g v, h w*, &c., which subtend the deflection angles, are called *deflection distances;* and the chord D *s*, which subtends the tangential angle, is called the *tangential distance.*

But although, in any given circle, the deflection distance is not *truly* twice the tangential distance, yet the difference is so trifling in large railroad curves, with chords of but 100 feet, that it may generally be neglected in curves of more than 300 feet radius.

In our tables the *precise* length of both will be found for different radii, and for chords of 100 feet.

Having these respective distances, we may frequently trace a curve on the ground by the eye only, with very tolerable accuracy, sufficient for guiding the excavations and embankments, especially on nearly level ground. Suppose, for instance, it be required to lay out in this manner a curve of 5730 feet radius.

First, find by the table, page 160, or by Art. XVI., the deflection distance *e t* or *f u*, &c., corresponding to a radius of 5730 feet for a chord of 100 feet—viz., 1·745 foot; and also the tangential distance *d s*, ·873 of a foot.

Then from the starting point B, and in line with A B, measure B D, equal 100 feet, and put a pin at D. Also from B, measure the chord B *s*, equal 100 feet; at the same time measuring with a graduated rod, from the pin D, the *tangential* distance D *s*, equal to ·873 of a foot; and place a stake at *s*. The pin at D may then be removed.

Next, make *s e* equal to 100 feet, placing a pin at *e*, precisely in line with *s* B; also from *s* measure *s t*, equal 100 feet; at the same time measuring with the rod, from the pin *e*, the *deflection* distance *e t*, equal to 1·745 foot. Place a stake at *t*, and remove the pin at *e*. In this manner proceed to find other points as far as the end of the curve at *v*.

In order to pass the curve, as at *v*, to a tangent *v* L, proceed as before, only using the tangential distance *h n*, instead of the deflection distance *h w*. (See Art. IV.)

This method is abundantly accurate for laying out curves on a canal or common road; and will occasionally answer very well, when carefully performed, for railroad curves, in the absence of an instrument. Thin straight rods, iron-pointed, and a plumb line should be used for ranging the points in the latter case.

The transit instrument is the best for tracing curves, and running lines generally. I prefer the graduations to run from the same zero, right and left, to 180° each way. There shonld be two verniers, graduated to minutes; by their means half or even quarter minutes may generally be estimated with considerable certainty. The telescope, revolving in a vertical plane, greatly expedites the laying off of exterior angles, after having first sighted backward to the point behind.

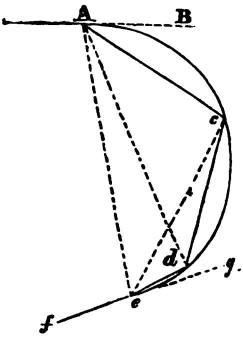
The verniers are sometimes graduated to hundredths of a degree; and this division is, in certain cases, the best; but for *general* purposes, the division into minutes is to be preferred, as all the printed tables of sines, tangents, &c., are calculated for that division.

ARTICLE IV.

On Sub-Chords.

We have hitherto spoken of curves as if they were composed of equal chords, each of 100 feet in length. It frequently happens, however, that at the end of a curve, as at *e*, fig. 4, we are obliged to use a shorter or sub-chord *d e*, in order to unite properly with the tangent *e f*.

Fig. 4.



In that case, and *when using Method* 1, *Art.* I., *of laying off curves by means of tangential angles*, we must, in order to fix the point *e*, lay off a *sub-tangential* angle *d* A *e*, as much smaller than the entire tangential angle B A *c*, or *c* A *d*, &c., as the sub-chord *de* is smaller than an entire 100 feet chord, *a c*, *c d*, &c. Thus, if the sub-chord be one-half, or one-fourth, &c., of the entire chord, the sub-tangential angle must be one-half, or one-fourth, &c., of the entire tangential angle.

This method is not mathematically exact, for the reason stated in Art. III. (viz., that the *chords* subtending different angles are not proportional to those angles); yet, for curves of 300 or more feet radius, and with chords not exceeding 100 feet in length, the error is not observable in practice.

In like manner, when we pass off from a sub-chord, as at *e*, to a second tangent, *e f*, we must place the instrument at *e*, and lay off the same sub-tangential angle *d e g*; or, which is better, take sight from *e* to *c*, and lay off the angle *c e g*, equal to the *sum* of a tangential and the sub-tangential angle.

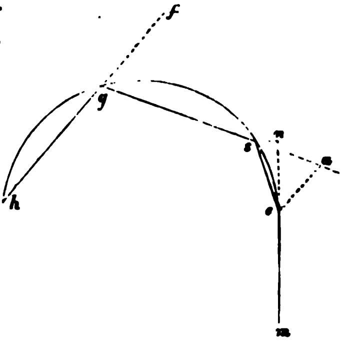
But *when using Method* 2, *Art.* II., *of deflection angles, or Method* 3, *Art.* III., *of deflection distances, we may calculate the sub-deflection angle* a s e, *fig.* 5, *and sub-deflection distance* a e, *formed between a sub-chord* s e, *and the extension* s a, *of an entire chord* g s, *with sufficient accuracy for curves of* 300 *or more feet radius, and chords of not more than* 100 *feet, thus:*

Rule.—Say, As an entire chord of 100 feet is to the sub-chord *s e*, so is the *deflection* angle of the curve to a certain angle. Add these two angles together and divide their sum by 2, for the sub-deflection angle *a s e* of the sub-chord.

Example.—The curve, fig. 5, has a radius of 319·6 feet, and an angle of deflection, *f g s* of 18° for chords of 100 feet. The sub-chord *s e* is 25 feet in length: what is the sub-deflection *angle a s e*; and also the sub-deflection *distance a e*, for the sub-chord *s e*?

	Chord.		Sub-Chord.
Here, as	100	is to	25,
	Def. An. of 100 feet cord.		Certain Angle.
So is	18°	to	4° 30′.

Fig. 5.



The sum of these two angles, 18° and 4° 30′ = 22° 30′, the half of which is 11° 15′, the required sub-deflection angle *a s e*.

Again, to find the sub-deflection distance *a e* of the sub-chord *s e*; take from the table of sines the natural sine of *one-half* the sub-deflection angle *a s e*, just found. Multiply this natural sine by 2, and multiply that product by the length of the sub-chord.

Example.—The sub-deflection angle is 11° 15′; one half of it is 5° 37½′, the tabular natural sine of which is ·0979, which, multiplied by 2, gives ·1958; this, multiplied by the sub-chord, 25 feet, gives 4·895 feet, the required sub-deflection distance *a e*.

Finally, to find the sub-tangential distance *s n*, by means of which to pass from *e* to the tangent *e m*, say, As 10000 is to the square of the sub-chord in feet, so is the *tangential* distance for 100 feet chord, to *s n*. In this instance, we have, As 10000 is to 625, so is 15·69 feet to ·980 foot, or *s n*.

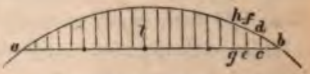
ARTICLE V.

Ordinates for Entire Chords.

It would be both tedious, and liable to inaccuracy, to attempt to fix all the necessary points in railroad curves by the foregoing means, which are employed only for entire chords, or for such sub-chords as may be required at the ends of curves.

The best method is to stretch a piece of twine *a b*, fig. 6, 100 feet long, between two adjacent chord-stakes, and measure off as nearly as may be at right angles to it, with a graduated rod, the previously calculated ordinates, *c d*, *e f*, *g h*, &c., placing pegs at *d*, *f*, *h*, &c.* Our table of ordinates, page 162, is calculated for distances apart *b c*, *c e*, *e g*, &c., of 5 feet; and for all curves likely to occur in practice. The 5 feet distances on the twine should be marked by knots or otherwise; and those at the centre, and half way between it and the ends, be further distinguished by tying on pieces of tape.

Fig. 6.



The 5 feet distances are only used (after the excavations and embankments are finished) for placing pegs to guide the laying of the rails, and then only for very sudden curves; for those of large radii, distances of 10 feet are quite sufficient, or even 25 feet for very easy curves. For guiding the curves of the cuttings and fillings, it is not necessary to place the stakes nearer than 50 feet apart; unless for those of less than about 1000 feet radius, when they may be placed 25 feet apart. Ordinates for radii intermediate of those in the table, may either be calculated by the rules given further on, or they may be taken proportionally intermediate of the tabular ones, with sufficient accuracy for practice.

Ordinates for Sub-Chords.

These may readily be calculated *approximately enough for railroad practice*, for curves of over 300 feet radius, and for chords not exceeding 100 feet, thus: In a circle of given radius, not less than about 300 feet, the ordinates of an entire 100 feet chord may be assumed to be to those of a sub-chord, as the square of the chord is to the square of the sub-chord.

---

* On the tops of these stakes small tacks are driven, to define the precise point in the curve.

In all our tables the chord is supposed to be 100 feet, the square of which is 10000; the rule therefore becomes, As 10000 feet : to square of sub-chord in feet : : Ord. of Chord : Ord. of Sub-chord *approximately*.

Example.—In a curve of 5730 feet radius, the middle ordinate of a 100 feet chord is ·218 of a foot; what will be the length of the middle ordinate of a sub-chord of 50 feet? Here,

Sq. of 100 ft.	:	Sq. of 50 ft.	: :	Mid. Ord. of Chord.	:	Mid. Ord. Sub-Chord *approximately*.
10000	:	2500	: :	·218 ft.	:	·0545 ft.

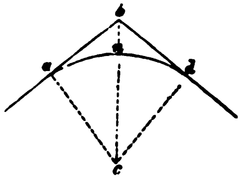
And so of any other ordinate, always supposing the chord and sub-chord to be divided into the *same number of parts*.

ARTICLE VI.

Having given the angle a b d, *fig.* 7, *it is required to find the point* a *or* d, *at which to commence a curve of given radius.*

Rule.—Subtract half the angle *a b d* from 90°; the remainder will be the angle *b c a* or *b c d*. From the table of tangents take the natural tangent of *b c a*, and multiply it by the given radius; the product will be *b a* or *b d*.

Fig. 7.



Example.—Let the angle *a b d* be 120°, how far from *b* must we begin, at *a* or *d*, to lay out a curve *a n d*, of 2865 feet radius?

Here, half of the angle *a b d* = 60°, which taken from 90° leaves the angle *b c a* = 30°. The natural tangent of 30° = ·5773, which, multiplied by the radius of 2865 feet, gives 1653·96 feet for *b a* or *b d*. (See Art. XII.)

ARTICLE VII.

Having given the angle a b d, *fig.* 7, *and the distance from* b *to* a *or* d, *at one of which we wish to commence a curve, it is required to find what radius* a c *or* c d *the curve must have, in order to unite with* b a *and* b d *tangentially at* a *and* d.

Rule.—Subtract the angle *a b c*, which is half the angle *a b d*, from 90°; the remainder will be the angle *b c a* or *b c d*. Then as nat. sine of *b c a*,* is to nat. sine of *a b c*,† so is *a b* to *a c*, the radius required.

Example.—Let the angle *a b d* be 120°, and the distance *b a* or *b d*

---

* The angle opposite the given side, *a b*.

† The angle opposite the required side, *a c*.

1654 feet; what will be the radius *a c* or *c d* of a circle that shall touch *a* and *d* tangentially?

Here, the angle *a b c* = half the angle *a b d*, is 60°, which, taken from 90°, leaves the angle *b c a* or *b c d* = 30°. Then as the nat. sine of *b c a* (30°) = ·5000 is to nat. sine of *a b c* (60°) = ·8660, so is *b a* (1654 feet) to *a c* (2865 feet), the radius required.

ARTICLE VIII.

Having given the radius a c, *fig.* 7, *of a curve, and the angle* a b d, *it is required to find the number of chords of* 100 *feet that will constitute the curve.*

Rule.—Subtract the angle *a b d* from 180°, and divide the remainder by the angle of curvature, or deflection of the curve. The quotient will be the required number of chords.

Example.—Let the angle *a b d* be 120°, and the radius *a c* 2865 feet.

Here, the angle *a b d*, 120°, subtracted from 180°, leaves a remainder of 60°; which, divided by 2°, the angle of deflection for a curve of 2865 feet, gives a quotient of 30; which is the required number of chords of 100 feet.

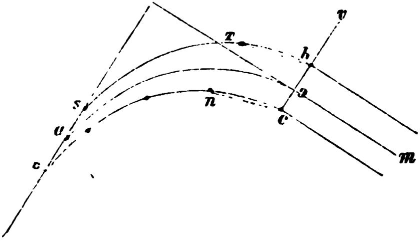
N. B.—Had the quotient contained a *fraction* of a chord, it would have indicated that we should have had to employ a sub-chord at the end of the curve; for instance, had the number of chords been 30½, a sub-chord of 50 feet (very approximately) would have been necessary.

ARTICLE IX.

How to proceed when the end of a curve does not correctly join the tangent.

We sometimes find, in running out a curve for the number of chords determined by the Rule in the preceding Article, that, instead of uniting as it should with the previously determined tangent *d m*, fig. 8, at *o*, it

Fig. 8.



ends tangentially to a line *parallel* to said tangent, either *within* it, as at *c*; or *beyond* it, as at *b*. Being first certain that no error has occurred in tracing out the curve, ascertain with the compass the bearing of the tangent *a d*, and, removing the compass to the end of the curve at *c* or *b*, (as the case may be,) run the line *b o* or *c o*, in the same course as *a d*, until it strikes the tangent *d o m;* which may be ascertained by ranging two stakes placed on the tangent.

Then measure *b o* or *c o*, (as the case may be,) and if the curve fall *within* the tangent *o m*, as at *c*, measure *forwards* from *t* towards *d* the distance *t a*, equal to *c o;* or if the curve fall *beyond* the tangent, as at *b*, measure *backwards* from *s* the distance *s a*, equal to *b o*. Then the curve retraced from *a* will terminate tangentially in *d m* at *o*.

N. B.—The direction of *c o* or *b o* may be ascertained without a compass, and better, thus: Multiply the *tangential* angle of the curve by *twice* the number of chords run, *less one;* subtract the product from 180°, and sighting back one chord to *n* or *r*, lay off the angle *n c b* or *r b v*, equal to the remainder. For example, if the tangential angle be 10°, and from *t* to *c* be 4 chords, then 7 times 10° taken from 180° leaves the angle *n c b* or *r b v* = 110°. When the product exceeds 180°, it must be subtracted from 360° for the angle *n c b* or *r b v*.*

This case occurs whenever an error has been made in measuring the distance from *d* to *a*. If *d a* be made too short, the curve *s b* is the result; and if too long, the curve *t c*.

If the error is small, it may be divided equally among the chords by measure without retracing the curve with an instrument. This method may be employed with perfect security so long as the error does not exceed 1 foot to every chord of 100 feet; and it will never be so great if moderate care be taken.

Thus, if the curve be 20 chords long, and the error 20 feet, the last stake may be moved 20 feet, the next 19, the next 18, &c., as nearly at right angles to the curve as can be judged by the eye.

The same ordinates that would have been used had the curve been correct, will answer for the one so adjusted, without perceptible difference. For other cases, see Art. X.

ARTICLE X.

Again, it may happen that the error is not caused by a mismeasurement of the distance *a e*, figs. 9 and 10, as in the last case; but by mistake in obtaining the angle *a e f*.

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* In both cases the angle is measured *outwardly* from the curve; but when the curve falls beyond the tangent, as at *b*, then *b v* must be continued inwardly as *b o*.

Fig. 9.

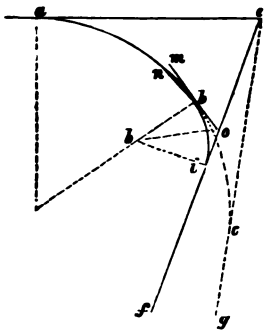
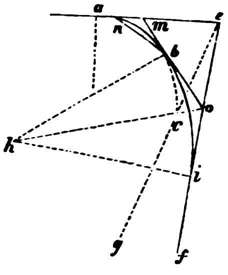


Fig. 10.



If *a e f*, fig. 9, be measured in excess, as *a e g*, then the curve *a b c*, calculated for the incorrect angle *a e g*, will be found to fall *beyond* the true tangent *e f*, as at *c*; and the tangents *e g* and *e f* not being parallel, the curve cannot be adjusted by either of the methods given in the preceding Article, unless the error be within about 1 foot to each 100 feet length of curve; in which case, (supposing no other error to exist,) either of those methods may be employed with sufficient accuracy for practice.

Also, if *a e f*, fig. 10, be measured too small, as *a e g*, then the curve *a b c*, calculated for the incorrect angle *a e g*, will be found to fall *within* the true tangent *e f*, as at *c*; when so, the remarks contained in the preceding sentence are equally applicable here. If the error be within 1 foot to 100 feet length of curve, it may be equally divided among the chords. But if greater, we must either remeasure the angle *a e f* correctly, and go over the whole work again, or resort to some other mode of obviating the difficulty. The angle *a e f* may be difficult of access; or the curve may be so long that to retrace it would be a work of much labour. We may then adopt the method of *compound curves*, (see Art. XIII.,) by which much trouble will be avoided, and a considerable portion of the first part of the curve be allowed to remain as it is.

Thus, whether the curve *a b c* fall beyond the true tangent *e f*, as in fig. 9, or inside of it, as in fig. 10, place the instrument at *b*, figs. 9 and 10, (the point at which the change of radius is to take place,) and sighting back one chord to *n*, lay off the tangential angle *n b m* of the curve *a b c*, and observe where the tangent *m b* continued strikes *e f*, as at *o*. Measure both *b o*, and the angle *b o f*. Half the angle *b o f* taken from 90° gives the angle *b h o*; then say,

As the {Nat. Sine of angle *b h o* opposite the given side *b o*} is to {Nat. Sine of angle *b o h* opposite the required side *b h*,

So is The given side *b o*, to The required side or new radius *b h*.

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Ascertain from the table, or by calculation, the angle of deflection and the tangential angle corresponding to this new radius *b h;* and the new curve commencing at *b* will terminate tangentially to *e f* at *i,* as far from *o* as *o* is from *b.*

For the mode of uniting two curves of different radii, so as to form a *compound* curve, see Article XIII.

It will be observed, that when the first curve *a b c,* fig. 10, falls *inside* the tangent *e f,* the new curve must be of *greater* radius; and when *beyond,* fig. 9, of a *less* one.

ARTICLE XI.

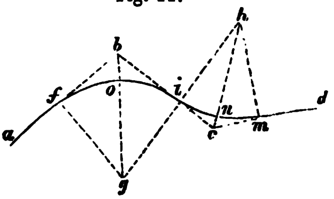
Having given the angles a b c *and* b c d, *fig.* 11, *and the distance* b c, *it is required to find the greatest radius,* g i *or* h i, *that can be employed in a* REVERSE *curve, (see Article* XIV.) f o i n m, *for uniting* a b *to* c d.

Rule.—Half the angle *a b c* taken from 90°, leaves the angle *b g i*; and half the angle *b c d* taken from 90°, leaves the angle *i h c.*

From the table of tangents take the natural tangent (*b i*) of the angle *b g i*; and that (*i c*) of the angle *i h c*; and add them together.

Then as the sum of these two nat. tangents is to the nat. tang. of *b g i,* so is *b c* to *b i*; and *b i* taken from *b c,* gives *i c.*

Fig. 11.



Again, in the triangle *b g i,* as the nat. sine of the angle *b g i,* opposite the given side *b i,* just found, is to the nat. sine of the angle *g b i,* opposite the required side *g i,* so is *b i,* the given side, to *g i,* the required side or radius.

Example.—Let the angle *a b c* be 71° 40′, the angle *b c d* 129° 15′, and the distance *b c* 950 feet. What is the length of radius *h i* or *g i,* of the easiest reverse curve that can be traced for uniting *a b* to *c d?*

Here, half the angle *a b c* (35° 50′) taken from 90°, leaves the angle *b g i* 54° 10′; and half the angle *b c d* (64° 37½′) taken from 90°, leaves the angle *i h c* = 25° 22½′.

From the table of tangents, we have nat. tang. of *b g i* (54° 10′) = 1·3848; and nat. tang. of *i h c* (25° 22½′) = ·4743; their sum being 1·8591.

Then as

$$\left.\begin{array}{c}\text{Sum of Tang's.}\\ 1{\cdot}8591\end{array}\right\}\text{ is to }\left\{\begin{array}{c}\text{Tang. of}\\ 54^\circ\,10'\\ 1{\cdot}3848,\end{array}\right\}\text{ so is }\left\{\begin{array}{c}b\ c\\ 950\text{ feet,}\end{array}\right\}\text{ to }\left\{\begin{array}{c}b\ i\\ 707{\cdot}63\text{ feet,}\end{array}\right.$$

and b i, 707·63 feet, taken from *b c,* 950 feet, leaves i c 242·37 feet.

Again, as the

Nat. Sine of angle *b g i* ·8107 is to Nat. Sine of angle *g b i* ·5854, so is *b i* 707·63 feet to *g i* or *h i*, the required radius, 510·97 feet.

ARTICLE XII.

To obtain the angle d b e, *formed by two tangents,* d b *and* b e, *when the point* b *is inaccessible.* Figs. 12, 13, 14, and 15.

This is of frequent occurrence.

Case 1. When the included figure, fig. 12, has but *three* sides.

Rule.—Subtract the angle *a d e* from 180° for the angle *b d e*; and subtract the angle *d e c* from 180° for the angle *d e b*. Add together *b d e* and *d e b*, and subtract their sum from 180° for the angle *d b e*.

Fig. 12.

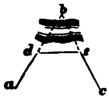


Fig. 13.

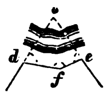


Fig. 14.

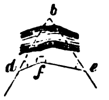
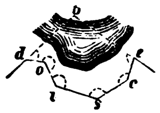


Fig. 15.



Case 2. When the included figure, *d b e f*, figs. 13 and 14, has *four* sides.

Rule.—Subtract the sum of the three *internal* angles of the figure marked by dotted segments of circle, from 360°, for the angle *d b e*.

Case 3. When the included figure, 15, has *more than four sides.*

Rule.—Add together all the *internal* angles, marked by dotted segments of circles; and subtract their sum from twice as many right angles as the figure has sides, less four, for the angle *d b e*.

Example.—Let the angles denoted by the dotted segments at the different letters be as follows: That at *d*, 70°; at *o*, 220°; at *i*, 150°; at *s*, 110°; at *c*, 160°; at *e*, 100°. The sum of these is 810°. The figure has 7 sides; and twice 7 less 4 = 10; and 10 right angles = 900°; from which the sum of the designated internal angles (810°) being subtracted, leaves 90°, for the angle *d b e*.

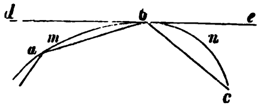
N.B.—When the angle *d b e* has to be deduced from a figure of many sides, as fig. 15, the errors spoken of in Articles IX. and X. are apt to occur, unless the several sides and the angles *o i s*, &c., be measured with much care. For tracing curves with any accuracy and satisfaction, the instrument should be divided at least into minutes; as before remarked, the transit instrument is the best for the purpose. With moderate care in the preparatory measurement of the sides and angles, errors will seldom occur that may not be adjusted with all the accuracy required in practice, by the very simple method of dividing them equally among the chords, as explained in Articles IX. and X.

ARTICLE XIII.

To pass from one curve, a m b, *fig.* 16, *to another,* b n c, *of different radius, but running in the same direction, constituting a* COMPOUND *curve.*

Rule.—Placing the instrument at *b*, sight back to the other end of the 100 feet chord at *a*; and lay off the *tangential* angle *a b d*, of the curve *a m b*; then from the common tangent *d b e* lay off the *tangential* angle *e b c*, of the curve *b n c*, making at the same time the chord *b c*, equal to 100 feet.

Fig. 16.



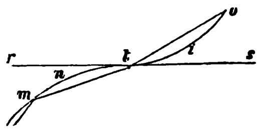
N.B.—If running the curve by eye, use the tangential *distances* instead of the angles.

ARTICLE XIV.

To pass from one curve, m n t, *fig.* 17, *to another,* t i o, *of either the same or of a different radius, but running in an opposite direction, constituting a* REVERSE *curve.*

Rule.—Placing the instrument at *t*, sight back to the other end of the 100 feet chord at *m*, and lay off the tangential angle *m t r*, of the curve *m n t*; then from the common tangent *r t s* lay off the tangential angle *s t o*, of the curve *t i o*, making at the same time the chord *t o*, equal to 100 feet.

Fig. 17.



N.B.—If running the curve by eye, use the tangential *distances* instead of the angles.

ARTICLE XV.

RADII.

To find the radius corresponding to any given angle of deflection, and to equal chords of any given length.

Rule 1.—Subtract the angle of deflection from 180°, then say, As nat. sine of angle of deflection is to nat. sine of *half* the remainder, so is the given chord to the radius required.

Example.—Let the angle of deflection be 2°, and the chord 100 feet; required the radius.

Here, 2° subtracted from 180° leaves 178°, the half of which is 89°, and as

Nat. Sine of 2° : Nat. Sine of 89° :: Chord : Radius
·034899 : ·999848 :: 100 feet : 2865 feet.

Rule 2.—The radius for 100 feet chords may be found *approximately*, by dividing 5730 by the deflection angle. This rule is very close for radii of not less than 500 feet. For 500 feet it gives eight-tenths of a foot too little, but is more approximate for larger radii.

Example.—What is the radius to a deflection angle of 2°, the chords being 100 feet long?

Here, 5730 divided by 2 gives 2865 feet, the radius required.

ARTICLE XVI.

TANGENTIAL AND DEFLECTION ANGLES.

To find either the Tangential or Deflection Angle corresponding to any given radius, and to equal chords of any given length.

Rule 1.—Divide *half* the chord by the radius; the quotient will be the natural sine of the *tangential* angle. Therefore the angle corresponding to this sine, in the Table of Natural Sines, will be the tangential angle required; and the tangential angle multiplied by 2 will give the deflection angle.

Example.—Let the radius be 2865 feet, and the chord 100 feet; what will be the tangential and deflection angles?

Here, half the chord (50 feet), divided by the radius (2865 feet), gives ·01745; and the tangential angle in the Table corresponding to the natural sine ·01745 is 1°, twice which is 2°, the deflection angle required.

Rule 2.—The deflection angle for 100 feet chords may be found approximately by dividing 5730 by the radius. This is very close for curves of over 500 feet radius. For 500 feet it gives about one minute too little.

Example.—What is the deflection angle for a radius of 2865 feet, the chords being 100 each?

Here, 5730 divided by the radius 2865 gives 2°, the deflection angle required.

ARTICLE XVII.

DEFLECTION DISTANCES.

To find the Deflection Distance (exactly) for any given radius, when the chords are 100 *feet long.*

Rule.—Divide the constant number 10000 by the radius in feet; the quotient will be the deflection angle required.*

Example.—What is the deflection distance to a radius of 5730 feet, the chords being 100 feet long?

Here, 10000 divided by 5730 radius gives 1·745 foot, the deflection distance required.

To find the Deflection Distance for any given radius, and for equal chords of any given length.

Rule.—Divide half the given chord by radius, the quotient will be the natural sine of one-*half* the deflection angle; and *double* this natural sine, multiplied by the chord, will give the deflection distance required. By this rule our Table was prepared.

Example.—As before, what is the deflection distance to a radius of 5730 feet, the chords being 100 feet long?

Here, half the chord (50 feet), divided by radius (5730 feet), gives ·008727, which is the natural sine of half the deflection angle. Now ·008727, multiplied by 2, gives ·017454, which, multiplied by the chord (100 feet), gives 1·745 foot, the required deflection distance, the same as in the preceding example.

ARTICLE XVIII.

TANGENTIAL DISTANCES.

To find the Tangential Distance corresponding to any given radius, and to equal chords of any given length.

Rule.—First find the tangential angle by Article XVI., and take from the Table of Natural Sines that corresponding to one-*half* of the *tangential* angle. Then multiply *double* this sine by the given chord, for the tangential distance. By this rule our Table was prepared.

Example.—Let the radius be 2865 feet, and the chords 100 feet each; what will be the tangential distance?

---

* Because the deflection distance to a radius of 10000 feet, with chords of 100 feet, is 1 foot; and the deflection distances for other radii increase *inversely* as the radii.

Here we find, by Article XVI., the tangential angle 1° for a radius of 2865 feet.

The natural sine corresponding to 30 minutes, or one-half of this tangential angle, is, by the Table of Sines, ·008727; the double of which is ·017454, which, multiplied by the chord, or 100 feet, gives 1·745 foot for the tangential distance required.

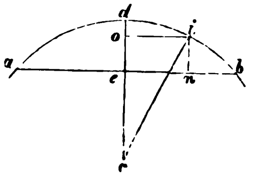
ARTICLE XIX.

ORDINATES.

To find the Middle Ordinate to any given radius, and to any given chord.

Rule 1.—From the square of the radius subtract the square of *half* the chord; and take the square root of the remainder from the radius, for the middle ordinate.

Fig. 18.



Example.—What is the length of the middle ordinate *d e*, fig. 18, the radius *c a* being 819 feet, and the chord *a b* 100 feet?

Here, the square of *c a* (819) is 670761, and the square of *a e* (50) is 2500; which, being subtracted from the former, leaves 668261; the square root of which is *e c*, 817·472; which, taken from the radius 819, leaves 1·528 foot, the required middle ordinate, *d e*.

Rule 2.—Subtract the tabular cosine of the *tangential* angle from 1, and multiply the remainder by the radius.

Example.—Same as foregoing; namely, radius 819 feet, angle of deflection 7°, to chords of 100 feet. What will be the length of the middle ordinate?

Here, tabular cosine of 3½° (the tangential angle) is ·998135; which, subtracted from 1, leaves ·001865; which, multiplied by 819, the radius, gives 1·527, the middle ordinate required.

ARTICLE XX.

Having given the Middle Ordinate d e, *fig.* 18, *it is required to find any other one, as* i n.

Rule 1.—Subtract the middle ordinate *d e* from the radius *d c*, the remainder will be *e c*: then from the square of the radius *c i* subtract the square of the distance *o i*, which the required ordinate *i n* is from the middle ordinate *d e*, and extract the square root of the remainder. This square root will be *o c*. From this square root *o c* subtract *e c*; the remainder will be *o e*, which is equal to *i n*, the required ordinate.

Example.—The middle ordinate *d e*, of a 100 feet chord *b a*, to a radius of 819, being 1·528 foot, it is required to find the length of the ordinate *i n*, 20 feet from the middle one.

Here, the middle ordinate *d e*, 1·528, subtracted from the radius 819, leaves *e c*, 817·472. The square of the radius is 670761; and the square of 20 (the distance of the required ordinate from the middle one) is 400; which, taken from 670761, leaves 670361; the square root of which is 818·756, or *o c*; from which take *e c*, or 817·472, and the remainder, 1·284, will be *o e*, which is equal to *i n*, the required ordinate.

Rule 2.—Multiply the ordinates of a 1° curve by the deflection angle of the curve whose ordinates are required (chords being 100 feet). This is a sufficiently close approximation for curves of not less than 500 feet radius; and for placing ordinates *for guiding the excavations and embankments*, it is close enough for the smallest curves in our Table.

I.—Table of Radii, &c.—*Chord* 100 *feet*.

The Tangential Angle is always one-half of the Angle of Deflection.

Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.	Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.
° ′ 1	343800	·029	·014	° ′ 51	6741	1·482	·741
2	171900	·058	·029	52	6611	1·511	·755
3	114600	·087	·043	53	6487	1·540	·770
4	85950	·116	·058	54	6367	1·569	·784
5	68760	·145	·072	55	6251	1·598	·799
6	57300	·174	·087	56	6139	1·627	·813
7	49116	·203	·101	57	6032	1·656	·828
8	42975	·232	·116	58	5928	1·685	·842
9	38200	·262	·131	59	5827	1·715	·857
10	34380	·291	·145	1	5730	1·745	·872
11	31256	·320	·160	2	5545	1·802	·901
12	28650	·349	·174	4	5372	1·860	·930
13	26446	·378	·189	6	5209	1·918	·959
14	24558	·407	·203	8	5056	1·976	·988
15	22920	·436	·218	10	4912	2·036	1·018
16	21487	·465	·232	12	4775	2·094	1·047
17	20224	·494	·247	14	4646	2·152	1·076
18	19100	·523	·261	16	4524	2·210	1·105
19	18094	·552	·276	18	4408	2·268	1·134
20	17190	·581	·290	20	4298	2·326	1·163
21	16372	·610	·305	22	4193	2·384	1·192
22	15628	·639	·319	24	4093	2·443	1·221
23	14948	·668	·334	26	3998	2·501	1·250
24	14325	·697	·348	28	3907	2·559	1·279
25	13752	·727	·363	30	3820	2·617	1·308
26	13223	·756	·378	32	3737	2·676	1·338
27	12733	·785	·392	34	3657	2·734	1·367
28	12279	·814	·407	36	3581	2·793	1·396
29	11856	·843	·421	38	3508	2·851	1·425
30	11460	·872	·436	40	3438	2·908	1·454
31	11090	·900	·450	42	3370	2·967	1·483
32	10744	·930	·465	44	3306	3·025	1·512
33	10419	·959	·479	46	3243	3·083	1·541
34	10112	·988	·494	48	3183	3·141	1·570
35	9823	1·017	·508	50	3126	3·199	1·599
36	9550	1·046	·523	52	3069	3·258	1·629
37	9292	1·075	·537	54	3016	3·316	1·658
38	9047	1·104	·552	56	2964	3·374	1·687
39	8815	1·133	·566	58	2914	3·432	1·716
40	8595	1·162	·581	2	2865	3·490	1·745
41	8385	1·191	·595	2	2818	3·548	1·774
42	8186	1·221	·610	4	2772	3·606	1·803
43	7995	1·250	·625	6	2729	3·665	1·832
44	7814	1·279	·639	8	2686	3·723	1·861
45	7640	1·308	·654	10	2644	3·781	1·890
46	7474	1·337	·668	12	2604	3·839	1·919
47	7315	1·366	·683	14	2566	3·897	1·948
48	7162	1·395	·697	16	2528	3·956	1·978
49	7016	1·424	·712	18	2491	4·014	2·007
50	6876	1·453	·726	20	2456	4·072	2·036

I.—Table of Radii, &c.—*continued.*

Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.	Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.
2° 22′	2421	4·130	2·065	4° 15′	1348	7·416	3·708
24	2387	4·188	2·094	20	1322	7·563	3·781
26	2355	4·246	2·123	25	1298	7·708	3·854
28	2323	4·305	2·152	30	1274	7·853	3·927
30	2292	4·363	2·182	35	1251	7·998	3·999
32	2262	4·421	2·210	40	1228	8·143	4·071
34	2232	4·479	2·239	45	1207	8·289	4·145
36	2204	4·538	2·269	50	1185	8·432	4·216
38	2176	4·596	2·298	55	1166	8·577	4·288
40	2149	4·653	2·326	5	1146	8·722	4·361
42	2122	4·712	2·356	5	1127	8·869	4·434
44	2096	4·770	2·385	10	1109	9·014	4·507
46	2071	4·828	2·414	15	1092	9·159	4·579
48	2046	4·886	2·443	20	1074	9·304	4·652
50	2023	4·944	2·472	25	1058	9·449	4·724
52	1999	5·002	2·501	30	1042	9·595	4·798
54	1976	5·060	2·530	35	1026	9·740	4·870
56	1953	5·118	2·559	40	1011	9·885	4·942
58	1932	5·176	2·588	45	996·8	10·03	5·015
3	1910	5·235	2·618	50	982·7	10·18	5·090
2	1889	5·293	2·646	55	969·0	10·32	5·160
4	1868	5·351	2·675	6	955·4	10·47	5·235
6	1848	5·409	2·704	5	947·5	10·62	5·310
8	1828	5·468	2·734	10	939·7	10·76	5·380
10	1810	5·526	2·763	15	917·0	10·90	5·450
12	1790	5·584	2·792	20	905·0	11·04	5·520
14	1772	5·642	2·821	25	893·5	11·20	5·600
16	1754	5·700	2·850	30	882·0	11·34	5·670
18	1736	5·758	2·879	35	870·7	11·48	5·740
20	1719	5·817	2·908	40	859·5	11·63	5·815
22	1702	5·875	2·937	45	849·3	11·78	5·890
24	1685	5·933	2·966	50	838·9	11·92	5·960
26	1669	5·992	2·996	55	828·9	12·06	6·030
28	1653	6·050	3·025	7	819·0	12·21	6·105
30	1637	6·108	3·054	5	813·3	12·36	6·180
32	1621	6·166	3·083	10	807·4	12·50	6·250
34	1606	6·224	3·112	15	790·8	12·64	6·320
36	1591	6·282	3·141	20	781·9	12·79	6·395
38	1577	6·340	3·170	25	773·2	12·94	6·470
40	1563	6·398	3·199	30	764·5	13·08	6·540
42	1549	6·456	3·228	35	756·1	13·22	6·610
44	1534	6·515	3·257	40	748·0	13·37	6·685
46	1521	6·574	3·287	45	739·9	13·51	6·755
48	1508	6·632	3·316	50	732·0	13·66	6·830
50	1495	6·690	3·345	55	724·3	13·80	6·900
52	1482	6·748	3·374	8	716·8	13·95	6·975
54	1469	6·806	3·403	15	695·1	14·38	7·190
56	1457	6·864	3·432	30	674·6	14·81	7·405
58	1445	6·922	3·461	45	655·5	15·25	7·625
4	1433	6·980	3·490	9	637·3	15·68	7·840
5	1403	7·125	3·562	15	620·2	16·12	8·060
10	1375	7·270	3·635	30	603·8	16·55	8·275

I.—TABLE OF RADII, &c.—*continued.*

Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.	Angle of Deflection.	Radius in feet.	Deflection distance in feet.	Tangential distance in feet.
9° 45′	588·4	16·99	8·495	17° ′	338·3	29·56	14·82
10	573·7	17·43	8·715	30	328·7	30·43	15·25
15	559·7	17·87	8·935	18	319·6	21·29	15·69
30	546·4	18·30	9·150	30	311·0	32·15	16·12
45	533·8	18·73	9·365	19	302·9	33·01	16·56
11	521·7	19·17	9·585	30	295·3	33·87	16·99
15	510·1	19·61	9·805	20	287·9	34·73	17·43
30	499·1	20·05	10·03	21	274·4	36·44	18·30
45	488·5	20·50	10·25	22	262·0	38·15	19·17
12	478·3	20·94	10·47	23	250·8	39·87	20·02
15	468·7	21·36	10·69	24	240·5	41·58	20·91
30	459·3	21·79	10·90	25	231·0	43·28	21·77
45	450·3	22·21	11·12	26	222·3	44·98	22·64
13	441·7	22·64	11·34	27	214·2	46·68	23·51
15	433·4	23·07	11·56	28	206·7	48·38	24·37
30	425·5	23·51	11·77	29	199·7	50·07	25·24
45	417·7	23·94	11·99	30	193·2	51·76	26·11
14	410·3	24·37	12·21	31	187·1	53·45	26·97
15	403·1	24·81	12·43	32	181·4	55·13	27·83
30	396·2	25·24	12·65	33	176·0	56·80	28·70
45	389·6	25·67	12·86	34	171·0	58·47	29·56
15	383·1	26·11	13·08	35	166·3	60·14	30·42
15	376·9	26·52	13·30	36	161·8	61·80	31·29
30	370·8	26·94	13·52	37	157·6	63·46	32·15
45	365·0	27·37	13·73	38	153·6	65·11	33·01
16	359·3	27·83	13·95	39	149·8	66·76	33·87
30	348·4	28·70	14·38	40	146·2	68·40	34·73

II.—TABLE OF ORDINATES.

Ordinates five feet apart.—Chord 100 *feet.*

	Distances of the Ordinates from the end of the 100 feet Chord.									
Angle of Deflection.	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° 2′	·007	·007	·007	·006	·006	·005	·003	·003	·002	·001
4	·014	·014	·014	·013	·012	·010	·008	·008	·005	·003
6	·021	·021	·021	·020	·019	·016	·013	·011	·008	·004
8	·029	·029	·028	·026	·024	·022	·018	·015	·010	·005
10	·036	·036	·035	·033	·031	·027	·023	·019	·013	·007
12	·043	·043	·041	·038	·037	·033	·028	·022	·015	·008
14	·050	·050	·048	·044	·043	·038	·032	·026	·017	·010
16	·058	·058	·056	·052	·049	·044	·037	·030	·020	·011
18	·065	·065	·063	·059	·055	·050	·042	·033	·023	·013
20	·073	·072	·070	·066	·061	·055	·047	·037	·026	·014
22	·080	·079	·076	·071	·067	·060	·051	·041	·029	·015

II.—TABLE OF ORDINATES—*continued.*

Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° ′ 24	·087	·086	·083	·077	·074	·066	·056	·045	·031	·017
26	·094	·093	·090	·084	·080	·071	·060	·048	·034	·018
28	·102	·101	·098	·092	·086	·077	·065	·052	·036	·019
30	·109	·108	·105	·099	·092	·082	·070	·055	·039	·020
32	·116	·115	·112	·106	·098	·088	·075	·058	·042	·022
34	·123	·122	·118	·111	·104	·094	·079	·062	·044	·023
36	·131	·130	·126	·119	·110	·099	·084	·066	·047	·024
38	·138	·137	·133	·126	·116	·105	·089	·070	·049	·025
40	·145	·144	·140	·133	·123	·110	·093	·074	·052	·027
42	·152	·150	·146	·138	·128	·115	·098	·077	·055	·028
44	·160	·158	·153	·145	·135	·121	·103	·081	·057	·030
46	·167	·165	·160	·152	·141	·126	·107	·085	·060	·032
48	·174	·172	·167	·158	·147	·132	·112	·088	·062	·033
50	·182	·180	·175	·166	·153	·138	·117	·092	·065	·034
52	·189	·187	·181	·171	·159	·143	·122	·095	·068	·035
54	·196	·194	·188	·178	·165	·148	·126	·099	·070	·036
56	·204	·202	·195	·185	·171	·154	·131	·103	·073	·038
58	·211	·209	·202	·192	·177	·159	·136	·107	·075	·039
1	·218	·216	·209	·198	·183	·164	·140	·111	·078	·041
2	·225	·223	·215	·204	·189	·169	·145	·114	·081	·042
4	·233	·231	·223	·211	·196	·175	·150	·118	·083	·043
6	·240	·238	·230	·217	·202	·180	·155	·121	·086	·045
8	·247	·245	·237	·224	·208	·186	·159	·125	·088	·046
10	·254	·252	·244	·231	·214	·191	·163	·130	·091	·048
12	·262	·260	·252	·237	·220	·196	·168	·133	·094	·049
14	·269	·267	·258	·244	·226	·202	·173	·136	·096	·050
16	·276	·274	·265	·251	·232	·207	·177	·140	·099	·052
18	·284	·282	·273	·257	·238	·213	·182	·144	·101	·053
20	·291	·288	·279	·264	·244	·218	·187	·148	·104	·055
22	·298	·295	·285	·270	·250	·224	·192	·151	·107	·056
24	·306	·303	·293	·277	·256	·229	·197	·155	·109	·057
26	·313	·310	·300	·284	·263	·235	·201	·159	·112	·059
28	·320	·317	·307	·291	·269	·240	·206	·163	·114	·060
30	·327	·324	·314	·297	·275	·246	·210	·167	·117	·062
32	·334	·331	·321	·304	·281	·251	·215	·171	·120	·063
34	·341	·338	·328	·310	·287	·257	·219	·174	·122	·065
36	·349	·345	·335	·317	·293	·262	·224	·178	·125	·066
38	·356	·353	·342	·323	·299	·268	·228	·182	·127	·068
40	·364	·360	·349	·330	·305	·273	·233	·185	·130	·069
42	·371	·367	·356	·337	·312	·278	·238	·189	·133	·070
44	·378	·374	·363	·343	·318	·284	·242	·192	·135	·072
46	·385	·382	·370	·350	·324	·289	·247	·196	·138	·073
48	·393	·389	·377	·356	·330	·295	·251	·200	·141	·075
50	·400	·396	·384	·364	·336	·300	·256	·204	·144	·076
52	·407	·403	·391	·370	·342	·305	·261	·208	·147	·077
54	·414	·410	·398	·376	·348	·311	·265	·211	·149	·079
56	·422	·418	·405	·383	·354	·316	·270	·215	·152	·080
58	·429	·425	·412	·389	·360	·322	·275	·219	·154	·082
2	·436	·432	·419	·397	·366	·327	·280	·222	·157	·083
2	·443	·439	·426	·402	·373	·332	·284	·226	·160	·084
4	·451	·446	·433	·409	·379	·338	·289	·230	·162	·086

II.—Table of Ordinates—*continued.*

	Distances of the Ordinates from the end of the 100 feet Chord.									
Angle of Deflection.	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
2° 6′	·458	·454	·440	·416	·385	·343	·293	·234	·165	·087
8	·465	·461	·447	·425	·391	·349	·298	237	·167	·088
10	·473	·468	·454	·430	·397	·355	·303	·241	·170	·089
12	·480	·475	·461	·437	·403	·360	·308	·245	·173	·090
14	·487	·482	·468	·443	·409	·366	·312	·248	·175	·092
16	·495	·490	·475	·450	·415	·371	·317	·252	·178	·093
18	·502	·497	·482	·456	·421	·377	·321	·256	·180	·095
20	·509	·504	·489	·463	·428	·382	·326	·260	·183	·096
22	·516	·511	·496	·470	·434	·387	·330	·264	·186	·097
24	·523	·518	·503	·476	·440	·393	·334	·267	·188	·099
26	·531	·526	·510	·483	·446	·398	·338	·271	·191	·100
28	·538	·533	·517	·489	·452	·404	·346	·275	·194	·102
30	·545	·540	·524	·496	·458	·409	·350	·278	·196	·103
32	·552	·547	·531	·503	·465	·415	·355	·282	·199	·104
34	·560	·554	·538	·509	·471	·420	·359	·285	·201	·106
36	·567	·562	·545	·516	·477	·425	·364	·289	·204	·107
38	·574	·569	·552	·522	·483	·431	·368	·293	·206	·109
40	·582	·576	·559	·529	·489	·436	·373	·297	·209	·110
42	·589	·583	·566	·536	·495	·441	·378	·301	·212	·111
44	·596	·590	·573	·542	·501	·447	·382	·304	·214	·113
46	·603	·598	·580	·549	·507	·452	·387	·308	·217	·114
48	·611	·605	·587	·555	·513	·458	·391	·312	·219	·116
50	·618	·612	·594	·562	·519	·464	·396	·315	·222	·117
52	·625	·619	·601	·569	·526	·469	·401	·319	·225	·118
54	·632	·626	·608	·575	·532	·474	·405	·322	·227	·119
56	·640	·634	·615	·582	·538	·480	·410	·326	·230	·121
58	·647	·641	·622	·588	·544	·485	·414	·330	·232	·123
3	·654	·648	·629	·595	·550	·491	·419	·334	·235	·124
2	·661	·655	·636	·602	·556	·497	·424	·338	·238	·125
4	·669	·662	·643	·608	·562	·502	·428	·341	·240	·127
6	·676	·670	·650	·615	·568	·507	·433	·345	·243	·128
8	·683	·677	·657	·621	·574	·512	·438	·349	·246	·130
10	·691	·684	·664	·629	·581	·518	·443	·353	·249	·131
12	·698	·691	·671	·635	·587	·523	·448	·357	·251	·132
14	·706	·698	·678	·642	·593	·529	·452	·360	·254	·134
16	·713	·705	·685	·649	·599	·534	·457	·364	·257	·135
18	·720	·713	·692	·655	·605	·540	·462	·368	·259	·137
20	·727	·720	·699	·662	·611	·545	·466	·371	·262	·138
22	·734	·727	·706	·668	·617	·550	·471	·375	·264	·139
24	·742	·734	·713	·675	·623	·556	·475	·378	·267	·141
26	·749	·742	·720	·682	·629	·561	·480	·382	·270	·142
28	·756	·749	·727	·688	·635	·567	·485	·386	·272	·144
30	·764	·756	·734	·695	·642	·573	·489	·390	·275	·145
32	·771	·763	·741	·702	·648	·578	·494	·394	·278	·146
34	·779	·770	·748	·708	·654	·584	·498	·397	·280	·148
36	·786	·777	·755	·715	·660	·589	·503	·401	·283	·149
38	·793	·785	·762	·721	·666	·594	·508	·405	·285	·151
40	·800	·792	·769	·728	·673	·600	·512	·408	·288	·152
42	·807	·799	·776	·734	·679	·605	·517	·412	·291	·153
44	·814	·806	·783	·741	·685	·611	·521	·415	·293	·155
46	·822	·814	·790	·748	·691	·616	·526	·419	·296	·156

II.—TABLE OF ORDINATES—*continued.*

Angle of De-ection.		Distances of the Ordinates from the end of the 100 feet Chord.									
		Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
°	′										
3	48	·829	·821	·797	·754	·697	.621	·531	·423	·298	·158
	50	·836	·828	·804	·761	·703	·627	·536	·427	·301	·159
	52	·843	·835	·811	·768	·709	·632	·541	·431	·304	·160
	54	·850	·842	·818	·774	·715	·638	·545	·434	·306	·162
	56	·858	·850	·825	·781	·721	·643	·550	·438	·309	·163
	58	·865	·857	·832	·787	·728	·648	·555	·442	·311	·165
4		·873	·864	·839	·794	·734	·655	·559	·445	·314	·166
	5	·891	·882	·856	·810	·749	·668	·571	·454	·320	·169
	10	·909	·900	·874	·827	·764	·682	·582	·464	·327	·173
	15	·927	·918	·891	·844	·780	·695	·594	·473	·334	·176
	20	·945	·936	·909	·860	·795	·709	·606	·482	·340	·179
	25	·963	·954	·926	·877	·810	·723	·617	·491	·347	·183
	30	·981	·972	·944	·893	·825	·736	·629	·501	·354	·186
	35	·999	·990	·961	·909	·840	·750	·640	·510	·360	·189
	40	1·017	1·008	·979	·926	·855	·764	·652	·519	·367	·193
	45	1·036	1·026	·996	·943	·871	·777	·664	·529	·373	·196
	50	1·054	1·044	1·014	·959	·886	·791	·676	·538	·380	·199
	55	1·072	1·062	1·031	·976	·901	·804	·687	·547	·386	·203
5		1·091	1·080	1·048	·993	·917	·818	·699	·557	·393	·207
	5	1·109	1·098	1·065	1·009	·932	·831	·711	·566	·400	·210
	10	1·127	1·116	1·083	1·026	·947	·845	·722	·576	·406	·214
	15	1·146	1·134	1·000	1·042	·963	·859	·734	·585	·413	·217
	20	1·164	1·152	1·118	1·058	·978	·872	·746	·594	·419	·220
	25	1·182	1·170	1·135	1·075	·993	·886	·757	·603	·426	·224
	30	1·200	1·188	1·153	1·092	1·009	·900	·769	·613	·432	·228
	35	1·218	1·206	1·170	1·108	1·024	·913	·781	·622	·438	·231
	40	1·236	1·224	1·188	1·124	1·039	·927	·792	·631	·445	·235
	45	1·255	1·242	1·205	1·141	1·055	·941	·804	·640	·452	·238
	50	1·273	1·260	1·223	1·157	1·070	·954	·816	·649	·458	·241
	55	1·291	1·278	1·240	1·174	1·085	·967	·827	·658	·465	·245
6		1·309	1·296	1·258	1·191	1·100	·982	·839	·668	·472	·248
	5	1·327	1·314	1·275	1·207	1·115	·995	·851	·677	·478	·251
	10	1·345	1·332	1·293	1·224	1·130	1·009	·862	·686	·485	·255
	15	1·364	1·350	1·310	1·240	1·146	1·023	·874	·696	·492	·259
	20	1·382	1·368	1·328	1·256	1·161	1·036	·886	·705	·498	·262
	25	1·400	1·386	1·345	1·273	1·176	1·050	·897	·714	·505	·266
	30	1·419	1·404	1·362	1·290	1·192	1·064	·909	·724	·511	·269
	35	1·437	1·422	1·379	1·306	1·207	1·077	·921	·733	·517	·272
	40	1·455	1·440	1·397	1·323	1·222	1·091	·932	·742	·524	·276
	45	1·473	1·458	1·415	1·339	1·238	1·105	·944	·752	·531	·280
	50	1·491	1·476	1·432	1·355	1·253	1·118	·956	·761	·537	·283
	55	1·509	1·494	1·450	1·372	1·268	1·132	·967	·770	·544	·287
7		1·528	1·512	1·467	1·389	1·284	1·146	·979	·779	·551	·290
	5	1·546	1·530	1·484	1·405	1·299	1·159	·991	·788	·557	·293
	10	1·564	1·548	1·502	1·422	1·314	1·173	1·002	·798	·564	·297
	15	1·582	1·566	1·520	1·438	1·330	1·187	1·014	·807	·570	·301
	20	1·600	1·584	1·537	1·454	1·345	1·200	1·026	·816	·576	·304
	25	1·618	1·602	1·555	1·471	1·360	1·214	1·037	·825	·583	·308
	30	1·637	1·620	1·572	1·488	1·375	1·228	1·048	·835	·590	·311
	35	1·655	1·638	1·589	1·504	1·390	1·241	1·060	·844	·596	·314
	40	1·673	1·656	1·607	1·521	1·405	1·255	1·071	·854	·603	·318

II.—Table of Ordinates—*continued.*

Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
° ′										
7 45	1·692	1·674	1·624	1·537	1·421	1·269	1·083	·863	·610	·321
50	1·710	1·692	1·641	1·553	1·436	1·282	1·095	·872	·616	·324
55	1·728	1·710	1·659	1·570	1·451	1·296	1·106	·881	·623	·328
8	1·746	1·728	1·677	1·587	1·467	1·310	1·118	·891	·629	·332
15	1·801	1·782	1·729	1·637	1·513	1·351	1·153	·918	·649	·342
30	1·855	1·836	1·782	1·687	1·559	1·392	1·188	·946	·669	·353
45	1·910	1·890	1·834	1·737	1·605	1·433	1·223	·974	·689	·363
9	1·965	1·944	1·886	1·787	1·651	1·474	1·258	1·002	·708	·373
15	2·019	1·998	1·939	1·837	1·696	1·515	1·293	1·030	·728	·384
30	2·074	2·052	1·991	1·887	1·742	1·556	1·328	1·057	·748	·394
45	2·128	2·106	2·044	1·937	1·788	1·597	1·363	1·085	·767	·405
10	2·183	2·161	2·096	1·987	1·834	1·637	1·398	1·114	·787	·415
15	2·238	2·215	2·148	2·037	1·880	1·678	1·433	1·142	·807	·425
30	2·292	2·269	2·201	2·087	1·926	1·719	1·468	1·170	·827	·436
45	2·347	2·323	2·254	2·136	1·972	1·761	1·503	1·198	·846	·446
11	2·401	2·377	2·306	2·186	2·018	1·802	1·538	1·226	·866	·457
15	2·456	2·432	2·359	2·236	2·064	1·843	1·574	1·254	·886	·467
30	2·511	2·486	2·411	2·286	2·110	1·884	1·609	1·282	·906	·478
45	2·566	2·540	2·464	2·336	2·156	1·926	1·644	1·310	·926	·488
12	2·620	2·594	2·516	2·386	2·203	1·967	1·680	1·339	·946	·499
15	2·675	2·649	2·569	2·436	2·249	2·008	1·715	1·367	·966	·509
30	2·730	2·703	2·621	2·485	2·295	2·049	1·750	1·395	·985	·520
45	2·785	2·757	2·674	2·535	2·341	2·091	1·785	1·423	1·005	·530
13	2·839	2·811	2·726	2·585	2·387	2·132	1·820	1·451	1·025	·541
15	2·894	2·865	2·779	2·635	2·433	2·173	1·855	1·479	1·045	·551
30	2·949	2·920	2·832	2·685	2·479	2·214	1·891	1·507	1·065	·562
45	3·000	2·974	2·884	2·735	2·525	2·256	1·926	1·535	1·085	·572
14	3·058	3·028	2·937	2·785	2·571	2·297	1·961	1·564	1·105	·583
15	3·113	3·082	2·989	2·834	2·618	2·338	1·996	1·592	1·124	·593
30	3·168	3·136	3·042	2·884	2·664	2·379	2·031	1·620	1·144	·604
45	3·222	3·191	3·094	2·934	2·710	2·421	2·067	1·648	1·164	·614
15	3·277	3·245	3·147	2·984	2·756	2·462	2·102	1·676	1·184	·625
15	3·332	3·299	3·200	3·034	2·802	2·503	2·137	1·704	1·204	·635
30	3·387	3·354	3·252	3·084	2·848	2·544	2·172	1·732	1·224	·646
45	3·442	3·408	3·305	3·134	2·895	2·586	2·208	1·760	1·244	·656
16	3·496	3·462	3·358	3·184	2·941	2·627	2·243	1·789	1·264	·667
30	3·606	3·571	3·463	3·284	3·033	2·710	2·314	1·845	1·304	·688
17	3·716	3·680	3·569	3·384	3·125	2·792	2·384	1·902	1·344	·709
30	3·826	3·788	3·674	3·484	3·218	2·875	2·455	1·958	1·384	·730
18	3·935	3·897	3·779	3·584	3·310	2·958	2·525	2·014	1·424	·751
30	4·045	4·006	3·885	3·684	3·403	3·040	2·596	2·071	1·464	·772
19	4·155	4·115	3·990	3·784	3·495	3·123	2·666	2·127	1·504	·793
30	4·265	4·223	4·096	3·884	3·588	3·205	2·737	2·184	1·544	·814
20	4·375	4·332	4·201	3·984	3·680	3·288	2·808	2·240	1·583	·836
21	4·595	4·549	4·412	4·184	3·864	3·454	2·950	2·353	1·663	·879
22	4·815	4·768	4·624	4·386	4·050	3·620	3·093	2·467	1·744	·922
23	5·035	4·986	4·836	4·587	4·237	3·786	3·236	2·581	1·824	·965
24	5·255	5·204	5·048	4·789	4·423	3·952	3·379	2·695	1·905	1·008
25	5·476	5·422	5·260	4·989	4·609	4·119	3·522	2·809	1·986	1·051
26	5·697	5·642	5·473	5·192	4·798	4·286	3·665	2·924	2·068	1·094
27	5·918	5·860	5·685	5·393	4·984	4·454	3·808	3·039	2·150	1·137

II.—Table of Ordinates—*continued.*

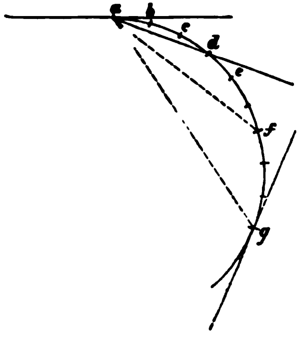
Angle of Deflection.	Distances of the Ordinates from the end of the 100 feet Chord.									
	Middle, 50 feet.	45 feet.	40 feet.	35 feet.	30 feet.	25 feet.	20 feet.	15 feet.	10 feet.	5 feet.
°										
28	6·139	6·079	5·898	5·595	5·171	4·622	3·952	3·154	2·232	1·181
29	6·361	6·298	6·110	5·796	5·357	4·790	4·095	3·269	2·314	1·224
30	6·582	6·517	6·323	5·999	5·544	4·958	4·239	3·385	2·396	1·268
31	6·804	6·737	6·537	6·202	5·733	5·127	4·384	3·502	2·481	1·312
32	7·027	6·957	6·751	6·406	5·922	5·297	4·530	3·619	2·565	1·356
33	7·249	7·178	6·965	6·609	6·111	5·467	4·676	3·737	2·649	1·401
34	7·472	7·398	7·179	6·813	6·300	5·637	4·822	3·854	2·733	1·445
35	7·694	7·619	7·393	7·017	6·489	5·807	4·968	3·972	2·817	1·490
36	7·918	7·841	7·609	7·222	6·679	5·978	5·115	4·090	2·901	1·535
37	8·143	8·063	7·825	7·427	6·870	6·149	5·262	4·209	2·985	1·581
38	8·367	8·286	8·041	7·633	7·060	6·320	5·410	4·327	3·069	1·626
39	8·592	8·508	8·257	7·838	7·251	6·491	5·557	4·446	3·153	1·672
40	8·816	8·731	8·474	8·044	7·442	6·663	5·705	4·565	3·238	1·718

ARTICLE XXI.

ON LONG CHORDS.

It is sometimes convenient, in preliminary locations, to lay off curves by chords longer than 100 feet. For instance, in fig. 19, instead of running from *a* by chords *ab*, *bc*, *cd*, &c., of but 100 feet, points *d*, *f*, *g*, &c., may be obtained with less trouble by using three times the tangential or deflection angles of the table, (as the case may be,) and employing chords *ad*, *df*, *fg*, &c., *nearly* three times as long as the chords *ab*, *bc*, &c.; or if *ad*, *df*, *fg* be either 2 or 4 stations apart, then 2 or 4 times the tangential and deflection angles would be used; and chords nearly 2 or 4 times 100 feet in length.

Fig. 19.



The following table contains the precise length of chord required to subtend respectively 1, 2, 3, or 4 stations. It is seldom desirable to exceed the latter limit.

III.—Table of Long Chords.

Radius in feet.	Angle of Deflection.	Length of Chord in feet required to subtend.			
		1 Station.	2 Stations.	3 Stations.	4 Stations.
5730·0	1°	100	200·0	300·0	400·0
4584·0	¼	100	200·0	300·0	399·9
3820·0	½	100	200·0	300·0	399·9
3274·0	¾	100	200·0	300·0	399·8
2865·0	2°	100	200·0	299·9	399·7
2547·0	¼	100	200·0	299·9	399·6
2292·0	½	100	200·0	299·8	399·5
2084·0	¾	100	200·0	299·8	399·4
1910·0	3°	100	200·0	299·7	399·3
1763·0	¼	100	200·0	299·7	399·2
1637·0	½	100	200·0	299·6	399·1
1528·0	¾	100	200·0	299·6	399·0
1433·0	4°	100	199·9	299·6	398·9
1348·0	¼	100	199·9	299·5	398·7
1274·0	½	100	199·9	299·4	398·5
1207·0	¾	100	199·9	299·3	398·3
1146·0	5°	100	199·9	299·2	398·0
1092·0	¼	100	199·8	299·1	397·8
1042·0	½	100	199·8	299·0	397·6
996·8	¾	100	199·7	298·9	397·5
955·4	6°	100	199·7	298·8	397·3
917·0	¼	100	199·7	298·7	397·0
882·0	½	100	199·7	298·6	396·7
849·3	¾	100	199·6	298·5	396·5
819·0	7°	100	199·6	298·4	396·2
790·8	¼	100	199·6	298·3	396·0
764·5	½	100	199·6	298·2	395·7
739·9	¾	100	199·6	298·1	395·4
716·8	8°	100	199·6	298·0	395·1
695·1	¼	100	199·5	297·9	394·8
674·6	½	100	199·5	297·8	394·5
655·5	¾	100	199·4	297·7	394·3
637·3	9°	100	199·4	297·5	394·1
620·2	¼	100	199·4	297·4	393·7
603·8	½	100	199·3	297·3	393·2
588·4	¾	100	199·2	297·2	392·8
573·7	10°	100	199·2	297·0	392·4

For radii less than 573·7 feet, it is never required to use longer chords than 100 feet.

When this method of laying out curves by long chords is used, the instrument should be moved to each successive point after it is determined, in order to fix the next one, instead of attempting to obtain more than one point from one position of the instrument: because when the chords are longer than one chain, they cannot be measured in the right direction by eye, but must be guided by the instrument.

It must be especially borne in mind that, in any given curve, only the tangential and deflection *angles* increase in the same proportion as the number of 100 feet stations subtended by the long chord. Therefore, *these* long chords cannot be used for laying out curves *by eye*, as their tangential and deflection *distances* are not known.

When it is required to use long chords for turning a curve *by eye*, they must be composed of a number of *whole chains*, being made say 200, 300, or 400, &c., feet in length. The tangential and deflection *distances* of curves of more than 500 feet radius may then be assumed, in practice, to increase as the *squares* of the number of chains in the length of the long chord. For instance, to lay off a 5° curve by chords of 200, 300, or 400 feet in length, the tangential and deflection distances of the table must be multiplied by 4, 9, or 16, as the case may be. In this case the tangential and deflection *angles* are unknown.

This is not mathematically correct, but will answer in practice for the curves of a canal or common road, where great nicety is not needed.

The only proper instrument for running lines of survey is the *transit*, furnished with a compass and with a revolving telescope. The deflections, being measured in *angles*, serve as a check to the numerous sources of error to which the compass is liable, arising from local attraction, electrical action in the glass cover, diurnal variation, &c. Besides, when the compass alone is used, it is necessary to test every course or bearing from each end of each station; and this involves loss of time.

The following is a good form of field-book for the transit and compass combined:

Station.	Distance.	Total Distance.	Course.	Deflection in Degrees.		The right hand page is left blank for Remarks, and Sketches of Topography.
				Left.	Right.	

In every locating party there should be one person whose duty is to obtain and record the transverse slopes of the ground at each station. His observations will usually extend to from fifty feet to one hundred yards on each side of the centre stakes, depending on a variety of circumstances of locality which cannot be alluded to here. In preliminary locations these slopes need not be taken with very great nicety, as they will be used chiefly for ascertaining, approximately, the amount of excavation and embankment.

After the final location is made, the slopes should be taken again, with great care, to the nearest quarter of a degree; but need not extend beyond the width actually occupied by the road. Their use in this second operation will be for determining the cubic contents with more precision than before, for final estimates; and also for obtaining the positions of the *side-stakes*.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

1 Deg. 1 Deg. 1 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0174524	·017455	57·28996	·9998477	60	21	·0235598	·023566	42·43346	·9997224	39	41	·0293755	·029388	34·02730	·9995684	19
1	·0177432	·017746	56·35059	·9998426	59	12	·0238506	·023857	41·91579	·9997156	38	42	·0296662	·029679	33·69350	·9995599	18
2	·0180341	·018037	55·44151	·9998374	58	23	·0241414	·024148	41·41058	·9997086	37	43	·0299570	·029970	33·36619	·9995512	17
3	·0183249	·018328	54·56130	·9998321	57	24	·0244322	·024439	40·91741	·9997015	36	44	·0302478	·030261	33·04517	·9995424	16
4	·0186158	·018619	53·70858	·9998267	56	25	·0247230	·024730	40·43583	·9996493	35	45	·0305385	·030552	32·73026	·9995336	15
5	·0189066	·018910	52·88211	·9998213	55	26	·0250138	·025021	39·96546	·9996871	34	46	·0308293	·030843	32·42129	·9995247	14
6	·0191974	·019201	52·08067	·9998157	54	27	·0253046	·025312	39·50589	·9996798	33	47	·0311200	·031135	32·11809	·9995157	13
7	·0194883	·019492	51·30315	·9998101	53	28	·0255954	·025603	39·05677	·9996724	32	48	·0314108	·031426	31·82051	·9995066	12
8	·0197791	·019783	50·54850	·9998044	52	29	·0258862	·025894	38·61773	·9996649	31	49	·0317015	·031717	31·52839	·9994974	11
9	·0200699	·020074	49·81572	·9997986	51	30	·0261769	·026185	38·18845	·9996573	30	50	·0319922	·032008	31·24157	·9994881	10
10	·0203608	·020365	49·10388	·9997927	50	31	·0264677	·026477	37·76861	·9996497	29	51	·0322830	·032299	30·95992	·9994788	9
11	·0206516	·020556	48·41208	·9997867	49	32	·0267585	·026768	37·35789	·9996419	28	52	·0325737	·032591	30·68330	·9994693	8
12	·0209424	·020947	47·73950	·9997807	48	33	·0270493	·027059	36·95600	·9996341	27	53	·0328644	·032882	30·41158	·9994598	7
13	·0212332	·021238	47·08534	·9997745	47	34	·0273401	·027350	36·56265	·9996262	26	54	·0331552	·033173	30·14461	·9994502	6
14	·0215241	·021529	46·44886	·9997683	46	35	·0276309	·027641	36·17759	·9996182	25	55	·0334459	·033464	29·88229	·9994405	5
15	·0218149	·021820	45·82935	·9997620	45	36	·0279216	·027932	35·80055	·9996101	24	56	·0337366	·033755	29·62449	·9994308	4
16	·0221057	·022111	45·22614	·9997556	44	37	·0282124	·028223	35·43128	·9996020	23	57	·0340274	·034047	29·37110	·9994209	3
17	·0223965	·022402	44·63859	·9997492	43	38	·0285032	·028514	35·06954	·9995937	22	58	·0343181	·034338	29·12200	·9994110	2
18	·0226873	·022693	44·06611	·9997426	42	39	·0287940	·028805	34·71511	·9995854	21	59	·0346088	·034629	28·87708	·9994009	1
19	·0229781	·022984	43·50812	·9997360	41	40	·0290847	·029097	34·36777	·9995770	20	60	·0348995	·034920	28·63625	·9993908	0
20	·0232690	·023275	42·96407	·9997292	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 88. Deg. 88. Deg. 88.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

2 Deg. 2 Deg. 2 Deg.

'	Sine.	Tang.	Cotang.	Cosine.	'	'	Sine.	Tang.	Cotang.	Cosine.	'	'	Sine.	Tang.	Cotang.	Cosine.	'
0	·0348995	·034920	28·63625	·9993908	60	21	·0410037	·041038	24·36750	·9991590	39	41	·0468159	·046867	21·33685	·9989035	19
1	·0351902	·035212	28·39939	·9993806	59	22	·0412944	·041329	24·19571	·9991470	38	42	·0471065	·047158	21·20494	·9988899	18
2	·0354809	·035503	28·16642	·9993704	58	23	·0415850	·041621	24·02632	·9991350	37	43	·0473970	·047450	21·07466	·9988761	17
3	·0357716	·035794	27·93723	·9993600	57	24	·0418757	·041912	23·85927	·9991228	36	44	·0476876	·047741	20·94596	·9988623	16
4	·0360623	·036085	27·71174	·9993495	56	25	·0421663	·042203	23·69453	·9991106	35	45	·0479781	·048033	20·81182	·9988484	15
5	·0363530	·036377	27·48985	·9993390	55	26	·0424569	·042495	23·53205	·9990983	34	46	·0482687	·048325	20·69322	·9988344	14
6	·0366437	·036668	27·27148	·9993284	54	27	·0427475	·042786	23·37177	·9990859	33	47	·0485592	·048616	20·56911	·9988203	13
7	·0369344	·036959	27·05655	·9993177	53	28	·0430382	·043078	23·21366	·9990734	32	48	·0488498	·048908	20·44648	·9988061	12
8	·0372251	·037250	26·84498	·9993069	52	29	·0433288	·043369	23·05767	·9990609	31	49	·0491403	·049199	20·32530	·9987919	11
9	·0375158	·037542	26·63669	·9992960	51	30	·0436194	·043660	22·90376	·9990482	30	50	·0494308	·049491	20·20555	·9987775	10
10	·0378065	·037833	26·43160	·9992851	50	31	·0439100	·043952	22·75189	·9990355	29	51	·0497214	·049782	20·08719	·9987631	9
11	·0380971	·038124	26·22963	·9992740	49	32	·0442006	·044243	22·60201	·9990227	28	52	·0500119	·050074	19·97021	·9987486	8
12	·0383878	·038416	26·03073	·9992629	48	33	·0444912	·044535	22·45409	·9990098	27	53	·0503024	·050366	19·85459	·9987340	7
13	·0386785	·038707	25·83482	·9992517	47	34	·0447818	·044826	22·30809	·9989968	26	54	·0505929	·050657	19·74029	·9987194	6
14	·0389692	·038998	25·64183	·9992404	46	35	·0450724	·045118	22·16398	·9989837	25	55	·0508835	·050949	19·62729	·9987046	5
15	·0392598	·039290	25·45170	·9992290	55	36	·0453630	·045409	22·02171	·9989706	24	56	·0511740	·051241	19·51558	·9986898	4
16	·0395505	·039581	25·26436	·9992176	44	37	·0456536	·045701	21·88125	·9989573	23	57	·0514645	·051532	19·40513	·9986748	3
17	·0398411	·039872	25·07975	·9992060	43	38	·0459442	·045992	21·74256	·9989440	22	58	·0517550	·051824	19·29592	·9986598	2
18	·0401318	·040164	24·89782	·9991944	42	39	·0462347	·046284	21·60563	·9989306	21	59	·0520455	·052116	19·18793	·9986447	1
19	·0404224	·040455	24·71851	·9991827	41	40	·0465253	·046575	21·47040	·9989171	20	60	·0523360	·052407	19·08113	·9986295	0
20	·0407131	·040746	24·54175	·9991709	40												
'	Cosine.	Cotan.	Tang.	Sine.	'	'	Cosine.	Cotan.	Tang.	Sine.	'	'	Cosine.	Cotan.	Tang.	Sine.	'

Deg. 87. Deg. 87. Deg. 87.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

3 Deg. 3 Deg. 3 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0523360	·052407	19·08113	·9986295	60	21	·0584352	·058535	17·08372	·9982912	39	41	·0642420	·064375	15·53398	·9979343	19
1	·0526264	·052699	18·97552	·9986143	59	22	·0587256	·058827	16·99895	·9982742	38	42	·0645323	·064667	15·46381	·9979156	18
2	·0529169	·052991	18·87106	·9985989	58	23	·0590160	·059119	16·91502	·9982570	37	43	·0648226	·064959	15·39427	·9978968	17
3	·0532074	·053282	18·76775	·9985835	57	24	·0593064	·059410	16·83191	·9982398	36	44	·0651129	·065251	15·32535	·9978779	16
4	·0534979	·053574	18·66556	·9985680	56	25	·0595967	·059702	16·74961	·9982225	35	45	·0654031	·065543	15·25705	·9978589	15
5	·0537883	·053866	18·56447	·9985524	55	26	·0598871	·059994	16·66811	·9982052	34	46	·0656934	·065835	15·18934	·9978399	14
6	·0540788	·054158	18·46447	·9985367	54	27	·0601775	·060286	16·58739	·9981877	33	47	·0659836	·066127	15·12224	·9978207	13
7	·0543693	·054449	18·36553	·9985209	53	28	·0604678	·060578	16·50745	·9981701	32	48	·0662739	·066419	15·05572	·9978015	12
8	·0546597	·054741	18·26765	·9985050	52	29	·0607582	·060870	16·42827	·9981525	31	49	·0665641	·666712	14·98978	·9977821	11
9	·0549502	·055033	18·17080	·9984891	51	30	·0610485	·061162	16·34985	·9981348	30	50	·0668544	·067004	14·92441	·9977627	10
10	·0552406	·055325	18·07497	·9984731	50	31	·0613389	·061454	16·27217	·9981170	29	51	·0671446	·067296	14·85961	·9977433	9
11	·0555311	·055616	17·98015	·9984570	49	32	·0616292	·061746	16·19522	·9980991	28	52	·0674349	·067588	14·79537	·9977237	8
12	·0558215	·055908	17·88631	·9984408	48	33	·0619196	·062038	16·11899	·9980811	27	53	·0677251	·067880	14·73167	·9977040	7
13	·0561119	·056200	17·79344	·9984245	47	34	·0622099	·062330	16·04348	·9980631	26	54	·0680153	·068173	14·66852	·9976843	6
14	·0564024	·056492	17·70152	·9984081	46	35	·0625002	·062622	15·96866	·9980450	25	55	·0683055	·068465	14·60591	·9976645	5
15	·0566928	·056784	17·61055	·9983917	45	36	·0627905	·062914	15·89454	·9980267	24	56	·0685957	·068757	14·54383	·9976445	4
16	·0569832	·057075	17·52051	·9983751	44	37	·0630808	·063206	15·82110	·9980084	23	57	·0688859	·069049	14·48227	·9976245	3
17	·0572736	·057367	17·43138	·9983585	43	38	·0633711	·063498	15·74833	·9979900	22	58	·0691761	·069342	14·42123	·9976045	2
18	·0575640	·057659	17·34315	·9983418	42	39	·0636614	·063790	15·67623	·9979716	21	59	·0694663	·069634	14·36069	·9975843	1
19	·0578544	·057951	17·25580	·9983250	41	40	·0639517	·064082	15·60478	·9979530	20	60	·0697565	·069926	14·30066	·9975641	0
20	·0581448	·058243	17·16933	·9983082	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 86. Deg. 86. Deg. 86.

4 Deg. 4 Deg. 4 Deg.

'	Sine.	Tang.	Cotang.	Cosine.	'	'	Sine.	Tang.	Cotang.	Cosine.	'	'	Sine.	Tang.	Cotang.	Cosine.	'
0	·0697565	·069926	14·30066	·9975641	60	21	·0758489	·076068	13·14612	·9971193	39	41	·0816486	·081922	12·20671	·9966612	19
1	·0700467	·070219	14·24113	·9975437	59	22	·0761390	·076360	13·09575	·9970972	38	42	·0819385	·082215	12·16323	·9966374	18
2	·0703368	·070511	14·18209	·9975233	58	23	·0764290	·076653	13·04576	·9970750	37	43	·0822284	·082507	12·12006	·9966135	17
3	·0706270	·070803	14·12353	·9975028	57	24	·0767190	·076945	12·99616	·9970528	36	44	·0825183	·082800	12·07719	·9965895	16
4	·0709171	·071096	14·06545	·9974822	56	25	·0770091	·077238	12·94692	·9970304	35	45	·0828082	·083093	12·03462	·9965655	15
5	·0712073	·071388	14·00785	·9974615	55	26	·0772991	·077531	12·89805	·9970080	34	46	·0830981	·083386	11·99234	·9965414	14
6	·0714974	·071680	13·95071	·9974408	54	27	·0775891	·077823	12·84955	·9969854	33	47	·0833880	·083679	11·95037	·9965172	13
7	·0717876	·071973	13·89404	·9974199	53	28	·0778791	·078116	12·80141	·9969628	32	48	·0836778	·083972	11·90868	·9964929	12
8	·0720777	·072265	13·83782	·9973990	52	29	·0781691	·078409	12·75363	·9969401	31	49	·0839677	·084265	11·86728	·9964685	11
9	·0723678	·072558	13·78206	·9973780	51	30	·0784591	·078701	12·70620	·9969173	30	50	·0842576	·084558	11·82616	·9964440	10
10	·0726580	·072850	13·72673	·9973569	50	31	·0787491	·078994	12·65912	·9968945	29	51	·0845474	·084851	11·78533	·9964195	9
11	·0729481	·073143	13·67185	·9973357	49	32	·0790391	·079287	12·61239	·9968715	28	52	·0848373	·085144	11·74477	·9963948	8
12	·0732382	·073435	13·61740	·9973145	48	33	·0793290	·079579	12·56599	·9968485	27	53	·0851271	·085437	11·70450	·9963701	7
13	·0735283	·073727	13·56339	·9972931	47	34	·0796190	·079872	12·51994	·9968254	26	54	·0854169	·085730	11·66449	·9963453	6
14	·0738184	·074020	13·50979	·9972717	46	35	·0799090	·080165	12·47422	·9968022	25	55	·0857067	·086023	11·62476	·9963204	5
15	·0741085	·074312	13·45662	·9972502	45	36	·0801989	·080458	12·42883	·9967789	24	56	·0859966	·086316	11·58529	·9962954	4
16	·0743986	·074605	13·40386	·9972286	44	37	·0804889	·080750	12·38376	·9967555	23	57	·0862864	·086609	11·54609	·9962704	3
17	·0746887	·074897	13·35151	·9972069	43	38	·0807788	·081043	12·33902	·9967321	22	58	·0865762	·086902	11·50715	·9962452	2
18	·0749787	·075190	13·29957	·9971851	42	39	·0810687	·081336	12·29460	·9967085	21	59	·0868660	·087195	11·46847	·9962200	1
19	·0752688	·075482	13·24803	·9971633	41	40	·0813587	·081629	12·25050	·9966849	20	60	·0871557	·087488	11·43005	·9961947	0
20	·0755589	·075775	13·19688	·9971413	40												
'	Cosine.	Cotan.	Tang.	Sine.	'	'	Cosine.	Cotan.	Tang.	Sine.	'	'	Cosine.	Cotan.	Tang.	Sine.	'

Deg. 85. Deg. 85. Deg. 85.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

3 Deg. 3 Deg. 3 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·0523360	·052407	19·08113	·9986295	60	21	·0584352	·058535	17·08372	·9982912	39	41	·0642420	·064375	15·53398	·9979343	19
1	·0526264	·052699	18·97552	·9986143	59	22	·0587256	·058827	16·99895	·9982742	38	42	·0645323	·064667	15·46381	·9979156	18
2	·0529169	·052991	18·87106	·9985989	58	23	·0590160	·059119	16·91502	·9982570	37	43	·0648226	·064959	15·39427	·9978968	17
3	·0532074	·053282	18·76775	·9985835	57	24	·0593064	·059410	16·83191	·9982398	36	44	·0651129	·065251	15·32535	·9978779	16
4	·0534979	·053574	18·66556	·9985680	56	25	·0595967	·059702	16·74961	·9982225	35	45	·0654031	·065543	15·25705	·9978589	15
5	·0537883	·053866	18·56447	·9985524	55	26	·0598871	·059994	16·66811	·9982052	34	46	·0656934	·065835	15·18934	·9978399	14
6	·0540788	·054158	18·46447	·9985367	54	27	·0601775	·060286	16·58739	·9981877	33	47	·0659836	·066127	15·12224	·9978207	13
7	·0543693	·054449	18·36553	·9985209	53	28	·0604678	·060578	16·50745	·9981701	32	48	·0662739	·066419	15·05572	·9978015	12
8	·0546597	·054741	18·26765	·9985050	52	29	·0607582	·060870	16·42827	·9981525	31	49	·0665641	·666712	14·98978	·9977821	11
9	·0549502	·055033	18·17080	·9984891	51	30	·0610485	·061162	16·34985	·9981348	30	50	·0668544	·067004	14·92441	·9977627	10
10	·0552406	·055325	18·07497	·9984731	50	31	·0613389	·061454	16·27217	·9981170	29	51	·0671446	·067296	14·85961	·9977433	9
11	·0555311	·055616	17·98015	·9984570	49	32	·0616292	·061746	16·19522	·9980991	28	52	·0674349	·067588	14·79537	·9977237	8
12	·0558215	·055908	17·88631	·9984408	48	33	·0619196	·062038	16·11899	·9980811	27	53	·0677251	·067880	14·73167	·9977040	7
13	·0561119	·056200	17·79344	·9984245	47	34	·0622099	·062330	16·04348	·9980631	26	54	·0680153	·068173	14·66852	·9976843	6
14	·0564024	·056492	17·70152	·9984081	46	35	·0625002	·062622	15·96866	·9980450	25	55	·0683055	·068465	14·60591	·9976645	5
15	·0566928	·056784	17·61055	·9983917	45	36	·0627905	·062914	15·89454	·9980267	24	56	·0685957	·068757	14·54383	·9976445	4
16	·0569832	·057075	17·52051	·9983751	44	37	·0630808	·063206	15·82110	·9980084	23	57	·0688859	·069049	14·48227	·9976245	3
17	·0572736	·057367	17·43138	·9983585	43	38	·0633711	·063498	15·74833	·9979900	22	58	·0691761	·069342	14·42123	·9976045	2
18	·0575640	·057659	17·34315	·9983418	42	39	·0636614	·063790	15·67623	·9979716	21	59	·0694663	·069634	14·36069	·9975843	1
19	·0578544	·057951	17·25580	·9983250	41	40	·0639517	·064082	15·60478	·9979530	20	60	·0697565	·069926	14·30066	·9975641	0
20	·0581448	·058243	17·16933	·9983082	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 86. Deg. 86. Deg. 86.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued*.

6 Deg. 6 Deg. 6 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1045285	·105104	9·514364	·9945219	60	21	·1106017	·111284	8·985984	·9938648	39	41	·1163818	·117178	8·534017	·9932045	19
1	·1048178	·105398	9·487814	·9944914	59	22	·1108908	·111578	8·962266	·9938326	38	42	·1166707	·117473	8·512594	·9931706	18
2	·1051070	·105692	9·461411	·9944609	58	23	·1111799	·111873	8·938672	·9938003	37	43	·1169596	·117767	8·491277	·9931367	17
3	·1053963	·105986	9·435153	·9944303	57	24	·1114689	·112168	8·915200	·9937679	36	44	·1172485	·118062	8·470065	·9931026	16
4	·1056856	·106280	9·409038	·9943996	56	25	·1117580	·112462	8·891850	·9937355	35	45	·1175374	·118357	8·448957	·9930685	15
5	·1059748	·106575	9·383066	·9943688	55	26	·1120471	·112757	8·868620	·9937029	34	46	·1178263	·118652	8·427953	·9930342	14
6	·1062641	·106869	9·357235	·9943379	54	27	·1123361	·113051	8·845510	·9936703	33	47	·1181151	·118947	8·407051	·9929999	13
7	·1065533	·107163	9·331545	·9943070	53	28	·1126252	·113346	8·822518	·9936375	32	48	·1184040	·119242	8·386251	·9929655	12
8	·1068425	·107457	9·305993	·9942760	52	29	·1129142	·113641	8·799644	·9936047	31	49	·1186928	·119537	8·365553	·9929310	11
9	·1071318	·107751	9·280580	·9942448	51	30	·1132032	·113935	8·776887	·9935719	30	50	·1189816	·119832	8·344955	·9928965	10
10	·1074210	·108046	9·255303	·9942136	50	31	·1134922	·114230	8·754246	·9935389	29	51	·1192704	·120127	8·324457	·9928618	9
11	·1077102	·108340	9·230162	·9941823	49	32	·1137812	·114525	8·731719	·9935058	28	52	·1195593	·120423	8·304058	·9928271	8
12	·1079994	·108634	9·205156	·9941510	48	33	·1140702	·114819	8·709307	·9934727	27	53	·1198481	·120718	8·283757	·9927922	7
13	·1082885	·108929	9·180283	·9941195	47	34	·1143592	·115114	8·687008	·9934395	26	54	·1201368	·121013	8·263554	·9927573	6
14	·1085777	·109223	9·155543	·9940880	46	35	·1146482	·115409	8·664822	·9934062	25	55	·1204256	·121308	8·243448	·9927224	5
15	·1088669	·109517	9·130934	·9940563	45	36	·1149372	·115703	8·642747	·9933728	24	56	·1207144	·121603	8·223438	·9926873	4
16	·1091560	·109812	9·106456	·9940246	44	37	·1152261	·115998	8·620783	·9933393	23	57	·1210031	·121898	8·203523	·9926521	3
17	·1094452	·110106	9·082107	·9939928	43	38	·1155151	·116293	8·598929	·9933057	22	58	·1212919	·122194	8·183704	·9926169	2
18	·1097343	·110401	9·057886	·9939610	42	39	·1158040	·116588	8·577183	·9932721	21	59	·1215806	·122489	8·163978	·9925816	1
19	·1100234	·110695	9·033793	·9939290	41	40	·1160929	·116883	8·555546	·9932384	20	60	·1218693	·122784	8·144346	·9925462	0
20	·1103126	·110989	9·009826	·9938969	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 83. Deg. 83. Deg. 83.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued*.

7 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1218693	·122784	8·144346	·9925462	60
1	·1221581	·123079	8·124807	·9925107	59
2	·1224468	·123375	8·105359	·9924751	58
3	·1227355	·123670	8·086004	·9924394	57
4	·1230241	·123965	8·066739	·9924037	56
5	·1233128	·124261	8·047564	·9923679	55
6	·1236015	·124556	8·028479	·9923319	54
7	·1238901	·124852	8·009483	·9922959	53
8	·1241788	·125147	7·990575	·9922599	52
9	·1244674	·125442	7·971755	·9922237	51
10	·1247560	·125738	7·953022	·9921874	50
11	·1250446	·126033	7·934375	·9921511	49
12	·1253332	·126329	7·915815	·9921147	48
13	·1256218	·126624	7·897339	·9920782	47
14	·1259104	·126920	7·878948	·9920416	46
15	·1261990	·127216	7·860642	·9920049	45
16	·1264875	·127511	7·842419	·9919682	44
17	·1267761	·127807	7·824279	·9919314	43
18	·1270646	·128103	7·806221	·9918944	42
19	·1273531	·128398	7·788245	·9918574	41
20	·1276416	·128694	7·770350	·9918204	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 82.

7 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·1279302	·128990	7·752536	·9917832	39
22	·1282186	·129285	7·734802	·9917459	38
23	·1285071	·129581	7·717148	·9917086	37
24	·1287956	·129877	7·699573	·9916712	36
25	·1290841	·130173	7·682076	·9916337	35
26	·1293725	·130469	7·664658	·9915961	34
27	·1296609	·130764	7·647317	·9915584	33
28	·1299494	·131060	7·630053	·9915206	32
29	·1302378	·131356	7·612865	·9914828	31
30	·1305262	·131652	7·595754	·9914449	30
31	·1308146	·131948	7·578717	·9914069	29
32	·1311030	·132244	7·561756	·9913688	28
33	·1313913	·132540	7·544869	·9913306	27
34	·1316797	·132836	7·528057	·9912923	26
35	·1319681	·133132	7·511317	·9912540	25
36	·1322564	·133428	7·494651	·9912155	24
37	·1325447	·133724	7·478057	·9911770	23
38	·1328330	·134020	7·461535	·9911384	22
39	·1331213	·134316	7·445085	·9910997	21
40	·1334096	·134612	7·428706	·9910610	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 82.

7 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·1336979	·134909	7·412397	·9910221	19
42	·1339862	·135205	7·396159	·9909832	18
43	·1342744	·135501	7·379990	·9909442	17
44	·1345627	·135797	7·363891	·9909051	16
45	·1348509	·136094	7·347861	·9908659	15
46	·1351392	·136390	7·331898	·9908266	14
47	·1354274	·136686	7·316004	·9907873	13
48	·1357156	·136983	7·300178	·9907478	12
49	·1360038	·137279	7·284418	·9907083	11
50	·1362919	·137575	7·268725	·9906687	10
51	·1365801	·137872	7·253098	·9906290	9
52	·1368683	·138168	7·237537	·9905893	8
53	·1371564	·138465	7·222042	·9905494	7
54	·1374445	·138761	7·206611	·9905095	6
55	·1377327	·139058	7·191245	·9904694	5
56	·1380208	·139354	7·175943	·9904293	4
57	·1383089	·139651	7·160705	·9903891	3
58	·1385970	·139947	7·145530	·9903489	2
59	·1388850	·140244	7·130419	·9903085	1
60	·1391731	·140540	7·115369	·9902681	0
′	Cosine.	Cotan.	Tang.	Sine.	′

8 Deg. 8 Deg. 8 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1391731	·140540	7·115369	·9902681	60	21	·1452197	·146775	6·813122	·9893994	39	41	·1509733	·152723	6·547767	·9885378	19
1	·1394612	·140837	7·100382	·9902275	59	22	·1455075	·147072	6·799356	·9893572	38	42	·1512608	·153021	6·535029	·9884939	18
2	·1397492	·141134	7·085457	·9901869	58	23	·1457953	·147369	6·785644	·9893148	37	43	·1515484	·153319	6·522339	·9884498	17
3	·1400372	·141430	7·070593	·9901462	57	24	·1460830	·147667	6·791986	·9892723	36	44	·1518359	·153617	6·509698	·9884057	16
4	·1403252	·141727	7·055790	·9901055	56	25	·1463708	·147964	6·758382	·9892298	35	45	·1521234	·153914	6·497104	·9883615	15
5	·1406132	·142024	7·041048	·9900646	55	26	·1466585	·148261	6·744831	·9891872	34	46	·1524109	·154212	6·484558	·9883172	14
6	·1409012	·142321	7·026366	·9900237	54	27	·1469463	·148559	6·731334	·9891445	33	47	·1526984	·154510	6·472059	·9882728	13
7	·1411892	·142617	7·011744	·9899826	53	28	·1472340	·148856	6·717889	·9891017	32	48	·1529858	·154808	6·459607	·9882284	12
8	·1414772	·142914	6·997180	·9899415	52	29	·1475217	·149153	6·704496	·9890588	31	49	·1532733	·155106	6·447201	·9881838	11
9	·1417651	·143211	6·982678	·9899003	51	30	·1478094	·149451	6·691156	·9890159	30	50	·1535607	·155404	6·434842	·9881392	10
10	·1420531	·143508	6·968233	·9898590	50	31	·1480971	·149748	6·677867	·9889728	29	51	·1538482	·155701	6·422530	·9880945	9
11	·1423410	·143805	6·953847	·9898177	49	32	·1483848	·150045	6·664630	·9889297	28	52	·1541356	·155999	6·410263	·9880497	8
12	·1426289	·144102	6·939519	·9897762	48	33	·1486724	·150343	6·651444	·9888865	27	53	·1544230	·156297	6·398042	·9880048	7
13	·1429168	·144399	6·925248	·9897347	47	34	·1489601	·150640	6·638310	·9888432	26	54	·1547104	·156595	6·385866	·9879599	6
14	·1432047	·144696	6·911035	·9896931	46	35	·1492477	·150938	6·625225	·9887998	25	55	·1549978	·156893	6·373735	·9879148	5
15	·1434926	·144993	6·896879	·9896514	45	36	·1495353	·151235	6·612191	·9887564	24	56	·1552851	·157191	6·361650	·9878697	4
16	·1437805	·145290	6·882780	·9896096	44	37	·1498230	·151533	6·599208	·9887128	23	57	·1555725	·157490	6·349609	·9878245	3
17	·1440684	·145587	6·868737	·9895677	43	38	·1501106	·151830	6·586273	·9886692	22	58	·1558598	·157788	6·337612	·9877792	2
18	·1443562	·145884	6·854750	·9895258	42	39	·1503981	·152128	6·573389	·9886255	21	59	·1561472	·158086	6·325660	·9877338	1
19	·1446440	·146181	6·840819	·9894838	41	40	·1506857	·152426	6·560553	·9885817	20	60	·1564345	·158384	6·313751	·9876883	0
20	·1449319	·146478	6·826943	·9894416	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 81. Deg. 81. Deg. 81.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

9 Deg. 9 Deg. 9 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1564345	·158384	6·313751	·9876883	60	21	·1624650	·164652	6·073397	·9867143	39	41	·1682026	·170633	5·860505	·9857524	19
1	·1567218	·158682	6·301886	·9876428	59	22	·1627520	·164951	6·062396	·9866670	38	42	·1684894	·170933	5·850241	·9857035	18
2	·1570091	·158980	6·290065	·9875972	58	23	·1630390	·165250	6·051434	·9866196	37	43	·1687761	·171232	5·840011	·9856544	17
3	·1572963	·159279	6·278286	·9875514	57	24	·1633260	·165548	6·040510	·9865722	36	44	·1690628	·171532	5·829817	·9856053	16
4	·1575836	·159577	6·266551	·9875057	56	25	·1636129	·165847	6·029624	·9865246	35	45	·1693495	·171831	5·819657	·9855561	15
5	·1578708	·159875	6·254858	·9874598	55	26	·1638999	·166146	6·018777	·9864770	34	46	·1696362	·172130	5·809531	·9855068	14
6	·1581581	·160174	6·243208	·9874138	54	27	·1641868	·166445	6·007967	·9864293	33	47	·1699228	·172430	5·799440	·9854574	13
7	·1584453	·160472	6·231600	·9873678	53	28	·1644738	·166744	5·997195	·9863815	32	48	·1702095	·172730	5·789382	·9854079	12
8	·1587325	·160770	6·220034	·9873216	52	29	·1647607	·167043	5·986461	·9863336	31	49	·1704961	·173029	5·779358	·9853583	11
9	·1590197	·161069	6·208510	·9872754	51	30	·1650476	·167342	5·975764	·9862856	30	50	·1707828	·173329	5·769368	·9853087	10
10	·1593069	·161367	6·197027	·9872291	50	31	·1653345	·167641	5·965104	·9862375	29	51	·1710694	·173628	5·759412	·9852590	9
11	·1595940	·161666	6·185586	·9871827	49	32	·1656214	·167940	5·954481	·9861894	28	52	·1713560	·173928	5·749488	·9852092	8
12	·1598812	·161964	6·174186	·9871363	48	33	·1659082	·168239	5·943895	·9861412	27	53	·1716425	·174228	5·739598	·9851593	7
13	·1601683	·162263	6·162827	·9870897	47	34	·1661951	·168539	5·933345	·9860929	26	54	·1719291	·174527	5·729741	·9851093	6
14	·1604555	·162561	6·151508	·9870431	46	35	·1664819	·168838	5·922832	·9860445	25	55	·1722156	·174827	5·719917	·9850593	5
15	·1607426	·162860	6·140230	·9869964	45	36	·1667687	·169137	5·912355	·9859960	24	56	·1725022	·175127	5·710125	·9850091	4
16	·1610297	·163159	6·128992	·9869496	44	37	·1670556	·169436	5·901913	·9859475	23	57	·1727887	·175427	5·700366	·9849589	3
17	·1613167	·163457	6·117794	·9869027	43	38	·1673423	·169735	5·891508	·9858988	22	58	·1730752	·175727	5·690639	·9849086	2
18	·1616038	·163756	6·106636	·9868557	42	39	·1676291	·170035	5·881138	·9858501	21	59	·1733617	·176027	5·680944	·9848582	1
19	·1618909	·164055	6·095517	·9868087	41	40	·1679159	·170334	5·870804	·9858013	20	60	·1736482	·176327	5·671281	·9848078	0
20	·1621779	·164353	6·084438	·9867615	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 80. Deg. 80.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

10 Deg. 10 Deg. 10 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1736482	·176327	5·671281	·9848078	60	21	·1796607	·182632	5·475478	·9837286	39	41	·1853808	·188650	5·300801	·9826668	19
1	·1739346	·176626	5·661650	·9847572	59	22	·1799469	·182933	5·466481	·9836763	38	42	·1856666	·188952	5·292350	·9826128	18
2	·1742211	·176926	5·652051	·9847066	58	23	·1802330	·183233	5.457512	·9836239	37	43	·1859524	·189253	5·283925	·9825587	17
3	·1745075	·177226	5·642483	·9846558	57	24	·1805191	·183534	5·448571	·9835715	36	44	·1862382	·189554	5·275525	·9825046	16
4	·1747939	·177527	5·632947	·9846050	56	25	·1808052	·183835	5·439659	·9835189	35	45	·1865240	·189855	5·267151	·9824504	15
5	·1750803	·177827	5·623442	·9845542	55	26	·1810913	·184135	5·430775	·9834663	34	46	·1868098	·190157	5·258803	·9823961	14
6	·1753667	·178127	5·613968	·9845032	54	27	·1813774	·184436	5·421918	·9834136	33	47	·1870956	·190458	5·250480	·9823417	13
7	·1756531	·178427	5·604524	·9844521	53	28	·1816635	·184737	5·413090	·9833608	32	48	·1873813	·190760	5·242183	·9822873	12
8	·1759395	·178727	5·595112	·9844010	52	29	·1819495	·185038	5·404290	·9833079	31	49	·1876670	·191061	5·233911	·9822327	11
9	·1762258	·179027	5·585730	·9843498	51	30	·1822355	·185339	5·395517	·9832549	30	50	·1879528	·191363	5·225664	·9821781	10
10	·1765121	·179327	5·576378	·9842985	50	31	·1825215	·185639	5·386771	·9832019	29	51	·1882385	·191664	5·217442	·9821234	9
11	·1767984	·179628	5·567057	·9842471	49	32	·1828075	·185940	5·378053	·9831487	28	52	·1885241	·191966	5·209245	·9820686	8
12	·1770847	·179928	5·557766	·9841956	48	33	·1830935	·186241	5·369363	·9830955	27	53	·1888098	·192268	2·201073	·9820137	7
13	·1773710	·180228	5·548505	·9841441	47	34	·1833795	·186542	5·369699	·9830422	26	54	·1890954	·192569	5·192926	·9819587	6
14	·1776573	·180529	5·539274	·9840924	46	35	·1836654	·186843	5·352062	·9829888	25	55	·1893811	·192871	5·184803	·9819037	5
15	·1779435	·180829	5·530072	·9840407	45	36	·1839514	·187144	5·343452	·9829353	24	56	·1896667	·193173	5·176705	·9818485	4
16	·1782298	·181129	5·520900	·9839889	44	37	·1842373	·187446	5·334869	·9828818	23	57	·1899523	·193474	5·168631	·9817933	3
17	·1785160	·181430	5·511757	·9839370	43	38	·1845232	·187747	5·326313	·9828282	22	58	·1902379	·193776	5·160581	·9817380	2
18	·1788022	·181730	5·502644	·9838850	42	39	·1848091	·188048	5·317783	·9827744	21	59	·1905234	·194078	5·152555	·9816826	1
19	·1790884	·182031	5·493560	·9838330	41	40	·1850949	·188349	5·309279	·9827206	20	60	·1908090	·194380	5·144554	·9816272	0
20	·1793746	·182331	5·484505	·9837808	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 79. Deg. 79. Deg. 79.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

11 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1908090	·194380	5·144554	·9816272	60
1	·1910945	·194682	5·136576	·9815716	59
2	·1913801	·194984	5·128622	·9815160	58
3	·1916656	·195286	5·120692	·9814603	57
4	·1919510	·195588	5·112785	·9814045	56
5	·1922365	·195890	5·104902	·9813486	55
6	·1925220	·196192	5·097042	·9812927	54
7	·1928074	·196494	5·089206	·9812366	53
8	·1930928	·196796	5·081392	·9811805	52
9	·1933782	·197098	5·073602	·9811243	51
10	·1936636	·197400	5·065835	·9810680	50
11	·1939490	·197703	5·058090	·9810116	49
12	·1942344	·198005	5·050369	·9809552	48
13	·1945197	·198307	5·042670	·9808986	47
14	·1948050	·198610	5·034993	·9808420	46
15	·1950903	·198912	5·027339	·9807853	45
16	·1953756	·199214	5·019707	·9807285	44
17	·1956609	·199517	5·012098	·9806716	43
18	·1959461	·199819	5·004511	·9806147	42
19	·1962314	·200122	4·996945	·9805576	41
20	·1965166	·200424	4·989402	·9805005	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 78.

11 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·1968018	·200727	4·981881	·9804433	39
22	·1970870	·201030	4·974381	·9803860	38
23	·1973722	·201332	4·966903	·9803286	37
24	·1976573	·201635	4·959447	·9802712	36
25	·1979425	·201938	4·952012	·9802136	35
26	·1982276	·202240	4·944599	·9801560	34
27	·1985127	·202543	4·937206	·9800983	33
28	·1987978	·202846	4·929835	·9800405	32
29	·1990829	·203149	4·922485	·9799827	31
30	·1993679	·203452	4·915157	·9799247	30
31	·1996530	·203755	4·907849	·9798667	29
32	·1999380	·204058	4·900562	·9798086	28
33	·2002230	·204361	4·893295	·9797504	27
34	·2005080	·204664	4·886049	·9796921	26
35	·2007930	·204967	4·878824	·9796337	25
36	·2010779	·205270	4·871620	·9795752	24
37	·2013629	·205573	4·864435	·9795167	23
38	·2016478	·205876	4·857271	·9794581	22
39	·2019327	·206180	4·850128	·9793994	21
40	·2022176	·206483	4·843004	·9793406	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 78.

11 Deg

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·2025024	·206786	4·835901	·9792818	19
42	·2027873	·207090	4·828817	·9792228	18
43	·2030721	·207393	4·821753	·9791638	17
44	·2033569	·207696	4·814709	·9791047	16
45	·2036418	·208000	4·807685	·9790455	15
46	·2039265	·208303	4·800680	·9789862	14
47	·2042113	·208607	4·793695	·9789268	13
48	·2044961	·208910	4·786730	·9788674	12
49	·2047808	·209214	4·779783	·9788079	11
50	·2050655	·209518	4·772856	·9787483	10
51	·2053502	·209821	4·765949	·9786886	9
52	·2056349	·210125	4·759060	·9786288	8
53	·2059195	·210429	4·752190	·9785689	7
54	·2062042	·210733	4·745340	·9785090	6
55	·2064888	·211036	4·738508	·9784490	5
56	·2067734	·211340	4·731695	·9783889	4
57	·2070580	·211644	4·714901	·9783287	3
58	·2073426	·211948	4·718125	·9782684	2
59	·2076272	·212252	4·711368	·9782080	1
60	·2079117	·212556	4·704630	·9781476	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 78.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

10 Deg. 10 Deg. 10 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·1736482	·176327	5·671281	·9848078	60	21	·1796607	·182632	5·475478	·9837286	39	41	·1853808	·188650	5·300801	·9826668	19
1	·1739346	·176626	5·661650	·9847572	59	22	·1799469	·182933	5·466481	·9836763	38	42	·1856666	·188952	5·292350	·9826128	18
2	·1742211	·176926	5·652051	·9847066	58	23	·1802330	·183233	5.457512	·9836239	37	43	·1859524	·189253	5·283925	·9825587	17
3	·1745075	·177226	5·642483	·9846558	57	24	·1805191	·183534	5·448571	·9835715	36	44	·1862382	·189554	5·275525	·9825046	16
4	·1747939	·177527	5·632947	·9846050	56	25	·1808052	·183835	5·439659	·9835189	35	45	·1865240	·189855	5·267151	·9824504	15
5	·1750803	·177827	5·623442	·9845542	55	26	·1810913	·184135	5·430775	·9834663	34	46	·1868098	·190157	5·258803	·9823961	14
6	·1753667	·178127	5·613968	·9845032	54	27	·1813774	·184436	5·421918	·9834136	33	47	·1870956	·190458	5·250480	·9823417	13
7	·1756531	·178427	5·604524	·9844521	53	28	·1816635	·184737	5·413090	·9833608	32	48	·1873813	·190760	5·242183	·9822873	12
8	·1759395	·178727	5·595112	·9844010	52	29	·1819495	·185038	5·404290	·9833079	31	49	·1876670	·191061	5·233911	·9822327	11
9	·1762258	·179027	5·585730	·9843498	51	30	·1822355	·185339	5·395517	·9832549	30	50	·1879528	·191363	5·225664	·9821781	10
10	·1765121	·179327	5·576378	·9842985	50	31	·1825215	·185639	5·386771	·9832019	29	51	·1882385	·191664	5·217442	·9821234	9
11	·1767984	·179628	5·567057	·9842471	49	32	·1828075	·185940	5·378053	·9831487	28	52	·1885241	·191966	5·209245	·9820686	8
12	·1770847	·179928	5·557766	·9841956	48	33	·1830935	·186241	5·369363	·9830955	27	53	·1888098	·192268	2·201073	·9820137	7
13	·1773710	·180228	5·548505	·9841441	47	34	·1833795	·186542	5·369699	·9830422	26	54	·1890954	·192569	5·192926	·9819587	6
14	·1776573	·180529	5·539274	·9840924	46	35	·1836654	·186843	5·352062	·9829888	25	55	·1893811	·192871	5·184803	·9819037	5
15	·1779435	·180829	5·530072	·9840407	45	36	·1839514	·187144	5·343452	·9829353	24	56	·1896667	·193173	5·176705	·9818485	4
16	·1782298	·181129	5·520900	·9839889	44	37	·1842373	·187446	5·334869	·9828818	23	57	·1899523	·193474	5·168631	·9817933	3
17	·1785160	·181430	5·511757	·9839370	43	38	·1845232	·187747	5·326313	·9828282	22	58	·1902379	·193776	5·160581	·9817380	2
18	·1788022	·181730	5·502644	·9838850	42	39	·1848091	·188048	5·317783	·9827744	21	59	·1905234	·194078	5·152555	·9816826	1
19	·1790884	·182031	5·493560	·9838330	41	40	·1850949	·188349	5·309279	·9827206	20	60	·1908090	·194380	5·144554	·9816272	0
20	·1793746	·182331	5·484505	·9837808	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 79. Deg. 79. Deg. 79.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

13 Deg. 13 Deg. 13 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2249511	·230868	4·331475	·9743701	60	21	·2308989	·237311	4·213869	·9729777	39	41	·2365555	·243465	4·107356	·9716180	19
1	·2252345	·231174	4·325734	·9743046	59	22	·2311819	·237618	4·208419	·9729105	38	42	·2368381	·243773	4·102164	·9715491	18
2	·2255179	·231481	4·320007	·9742390	58	23	·2314649	·237926	4·202983	·9728432	37	43	·2371207	·244081	4·096985	·9714802	17
3	·2258013	·231787	4·314295	·9741734	57	24	·2317479	·238233	4·197560	·9727759	36	44	·2374033	·244390	4·091817	·9714112	16
4	·2260846	·232094	4·308597	·9741077	56	25	·2320309	·238541	4·192151	·9727084	35	45	·2376859	·244698	4·086662	·9713421	15
5	·2263680	·232400	4·302913	·9740419	55	26	·2323138	·238848	4·186754	·9726409	34	46	·2379684	·245006	4·081519	·9712729	14
6	·2266513	·232707	4·297244	·9739760	54	27	·2325967	·239156	4·181371	·9725733	33	47	·2382510	·245315	4·076389	·9712036	13
7	·2269346	·233014	4·291588	·9739100	53	28	·2328796	·239463	4·176001	·9725056	32	48	·2385335	·245623	4·071270	·9711343	12
8	·2272179	·233320	4·285947	·9738439	52	29	·2331625	·239771	4·170644	·9724378	31	49	·2388159	·245932	4·066164	·9710649	11
9	·2275012	·233627	4·280319	·9737778	51	30	·2334454	·240078	4·165299	·9723699	30	50	·2390984	·246240	4·061070	·9709953	10
10	·2277844	·233934	4·274706	·9737116	50	31	·2337282	·240386	4·159968	·9723020	29	51	·2393808	·246549	4·055987	·9709258	9
11	·2280677	·234241	4·269107	·9736453	49	32	·2340110	·240694	4·154650	·9722339	28	52	·2396633	·246857	4·050917	·9708561	8
12	·2283509	·234547	4·263521	·9735789	48	33	·2342938	·241001	4·149344	·9721658	27	53	·2399457	·247166	4·045859	·9707863	7
13	·2286341	·234854	4·257950	·9735124	47	34	·2345766	·241309	4·144051	·9720976	26	54	·2402280	·247475	4·040812	·9707165	6
14	·2289172	·235161	4·252392	·9734458	46	35	·2348594	·241617	4·138771	·9720294	25	55	·2405104	·247783	4·035777	·9706466	5
15	·2292004	·235468	4·246848	·9733792	45	36	·2351421	·241925	4·133504	·9719610	24	56	·2407927	·248092	4·030755	·9705766	4
16	·2294835	·235775	4·241317	·9733125	44	37	·2354248	·242233	4·128249	·9718926	23	57	·2410751	·248401	4·025744	·9705065	3
17	·2297666	·236082	4·235800	·9732457	43	38	·2357075	·242541	4·123007	·9718240	22	58	·2413574	·248710	4·020744	·9704363	2
18	·2300497	·236390	4·230297	·9731789	42	39	·2359902	·242849	4·117778	·9717554	21	59	·2416396	·249019	4·015757	·9703660	1
19	·2303328	·236697	4·224808	·9731119	41	40	·2362729	·243157	4·112561	·9716867	20	60	·2419219	·249328	4·010780	·9702957	0
20	·2306159	·237004	4·219331	·9730449	40												
′	C sine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 76. Deg. 76. Deg. 76.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

14 Deg. | 14 Deg. | 14 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	
0	·2419219	·249328	4·010780	·9702957	60	21	·2478445	·255826	3·908901	·9687998	39	41	·2534766	·262034	3·816295	·9673415	19
1	·2422041	·249637	4·005816	·9702253	59	22	·2481263	·256136	3·904171	·9687277	38	42	·2537579	·262345	3·811773	·9672678	18
2	·2424863	·249946	4·000863	·9701548	58	23	·2484081	·256446	3·899451	·9686555	37	43	·2540393	·262656	3·807260	·9671939	17
3	·2427685	·250255	3·995922	·9700842	57	24	·2486899	·256756	3·894742	·9685832	36	44	·2543206	·262967	3·802758	·9671200	16
4	·2430507	·250564	3·990992	·9700135	56	25	·2489716	·257066	3·890044	·9685108	35	45	·2546019	·263278	3·798266	·9670459	15
5	·2433329	·250873	3·986073	·9699428	55	26	·2492533	·257376	3·885357	·9684383	34	46	·2548832	·263589	3·793783	·9669718	14
6	·2436150	·251182	3·981166	·9698720	54	27	·2495350	·257686	3·880680	·9683658	33	47	·2551645	·263900	3·789310	·9668977	13
7	·2438971	·251491	3·976271	·9698011	53	28	·2498167	·257997	3·876014	·9682931	32	48	·2554458	·264211	3·784848	·9668234	12
8	·2441792	·251801	3·971386	·9697301	52	29	·2500984	·258307	3·871358	·9682204	31	49	·2557270	·264522	3·780395	·9667490	11
9	·2444613	·252110	3·966513	·9696591	51	30	·2503800	·258617	3·866713	·9681476	30	50	·2560082	·264833	3·775951	·9666746	10
10	·2447433	·252420	3·961651	·9695879	50	31	·2506616	·258928	3·862078	·9680748	29	51	·2562894	·265145	3·771518	·9666001	9
11	·2450254	·252729	3·956801	·9695167	49	32	·2509432	·259238	3·857453	·9680018	28	52	·2565705	·265456	3·767094	·9665255	8
12	·2453074	·253038	3·951961	·9694453	48	33	·2512248	·259548	3·852839	·9679288	27	53	·2568517	·265768	3·762680	·9664508	7
13	·2455894	·253348	3·947133	·9693740	47	34	·2515063	·259859	3·848235	·9678557	26	54	·2571328	·266079	3·758276	·9663761	6
14	·2458713	·253658	3·942315	·9693025	46	35	·2517879	·260169	3·843642	·9677825	25	55	·2574139	·266390	3·753881	·9663012	5
15	·2461533	·253967	3·937509	·9692309	45	36	·2520694	·260480	3·839059	·9677092	24	56	·2576950	·266702	3·749496	·9662263	4
16	·2464352	·254277	3·932714	·9691593	44	37	·2523508	·260791	3·834486	·9676358	23	57	·2579760	·267014	3·745120	·9661513	3
17	·2467171	·254587	3·927929	·9690875	43	38	·2526323	·261101	3·829923	·9675624	22	58	·2582570	·267325	3·740754	·9660762	2
18	·2469990	·254896	3·923156	·9690157	42	39	·2529137	·261412	3·825370	·9674888	21	59	·2585381	·267637	3·736398	·9660011	1
19	·2472809	·255206	3·918393	·9689438	41	40	·2531952	·261723	3·820828	·9674152	20	60	·2588190	·267949	3·732050	·9659258	0
20	·2475627	·255516	3·913642	·9688719	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 75. | Deg. 75. | Deg. 75.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

15 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2588190	·267949	3·732050	·9659258	60
1	·2591000	·268261	3·727713	·9658505	59
2	·2593810	·268572	3·723384	·9657751	58
3	·2596619	·268884	3·719065	·9656996	57
4	·2599428	·269196	3·714756	·9656240	56
5	·2602237	·269508	3·710455	·9655484	55
6	·2605045	·269820	3·706164	·9654726	54
7	·2607853	·270132	3·701883	·9653968	53
8	·2610662	·270444	3·697610	·9653209	52
9	·2613469	·270757	3·693346	·9652449	51
10	·2616277	·271069	3·689092	·9651689	50
11	·2619085	·271381	3·684847	·9650927	49
12	·2621892	·271694	3·680611	·9650165	48
13	·2624699	·272006	3·676384	·9649402	47
14	·2627506	·272318	3·672166	·9648638	46
15	·2630312	·272631	3·667957	·9647873	45
16	·2633118	·272943	3·663757	·9647108	44
17	·2635925	·273256	3·659566	·9646341	43
18	·2638730	·273569	3·655384	·9645574	42
19	·2641536	·273881	3·651211	·9644806	41
20	·2644342	·274194	3·547046	·9644037	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 74.

15 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·2647147	·274507	3·642891	·9643268	39
22	·2649952	·274820	3·638744	·9642497	38
23	·2652757	·275133	3·634606	·9641726	37
24	·2655561	·275445	3·630477	·9640954	36
25	·2658366	·275758	3·626356	·9640181	35
26	·2661170	·276071	3·622244	·9639407	34
27	·2663973	·276385	3·618141	·9638633	33
28	·2666777	·276698	3·614046	·9637858	32
29	·2669581	·277011	3·609960	·9637081	31
30	·2672384	·277324	3·605883	·9636305	30
31	·2675187	·277637	3·601814	·9635527	29
32	·2677989	·277951	3·597754	·9634748	28
33	·2680792	·278264	3·593702	·9633969	27
34	·2683594	·278578	3·589659	·9633189	26
35	·2686396	·278891	3·585624	·9632408	25
36	·2689198	·279205	3·581597	·9631626	24
37	·2692000	·279518	3·577579	·9630843	23
38	·2694801	·279832	3·573569	·9630060	22
39	·2697602	·280145	3·569568	·9629275	21
40	·2700403	·280459	3·565574	·9628490	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 74.

15 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·2703204	·280773	3·561590	·9627704	19
42	·2706004	·281087	3·557613	·9626917	18
43	·2708805	·281401	3·553644	·9626130	17
44	·2711605	·281715	3·549684	·9625342	16
45	·2714404	·282029	3·545732	·9624552	15
46	·2717204	·282343	3·541788	·9623762	14
47	·2720003	·282657	3·537852	·9622972	13
48	·2722802	·282971	3·533925	·9622180	12
49	·2725601	·283285	3·530005	·9621387	11
50	·2728400	·283599	3·526093	·9620594	10
51	·2731198	·283914	3·522190	·9619800	9
52	·2733997	·284228	3·518294	·9619005	8
53	·2736794	·284543	3·514407	·9618210	7
54	·2739592	·284857	3·510527	·9617413	6
55	·2742390	·285172	3·506655	·9616616	5
56	·2745187	·285486	3·502791	·9615818	4
57	·2747984	·285801	3·498935	·9615019	3
58	·2750781	·286115	3·495087	·9614219	2
59	·2753577	·286430	3·491247	·9613418	1
60	·2756374	·286745	3·487414	·9612617	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 74.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

16 Deg. 16 Deg. 16 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2756374	·286745	3·487414	·9612617	60	21	·2815042	·293368	3·408688	·9595600	39	41	·2870819	·299697	3·336699	9579060	19
1	·2759170	·287060	3·483589	·9611815	59	22	·2817833	·293683	3·405021	·9594781	38	42	·2873605	·300014	3·333173	·9578225	18
2	·2761965	·287375	3·479772	·9611012	58	23	·2820624	·293999	3·401361	·9593961	37	43	·2876391	·300331	3·329654	·9577389	17
3	·2764761	·287690	3·475963	·9610208	57	24	·2823415	·294316	3·397708	·9593140	36	44	·2879177	·300648	3·326141	·9576552	16
4	·2767556	·288005	3·472161	·9609403	56	25	·2826205	·294632	3·394063	·9592318	35	45	·2881963	·300965	3·322636	·9575714	15
5	·2770352	·288320	3·468367	·9608598	55	26	·2828995	·294948	3·390424	·9591496	34	46	·2884748	·301283	3·319137	·9574875	14
6	·2773147	·288635	3·464581	·9607792	54	27	·2831785	·295264	3·386793	·9590672	33	47	·2887533	·301600	3·315645	·9574035	13
7	·2775941	·288950	3·460802	·9606984	53	28	·2834575	·295580	3·383169	·9589848	32	48	·2890318	·301917	3·312159	·9573195	12
8	·2778736	·289265	3·457031	·9606177	52	29	·2837364	·295897	3·379553	·9589023	31	49	·2893103	·302235	3·308681	·9572354	11
9	·2781530	·289580	3·453267	·9605368	51	30	·2840153	·296213	3·375943	·9588197	30	50	·2895887	·302552	3·305209	·9571512	10
10	·2784324	·289896	3·449512	·9604558	50	31	·2842942	·296529	3·372340	9587371	29	51	·2898671	·302870	3·301743	·9570669	9
11	·2787118	·290211	3·445763	·9603748	49	32	·2845731	·296846	3·368745	·9586543	28	52	·2901455	·303187	3·298285	·9569825	8
12	·2789911	·290526	3·442022	·9602937	48	33	·2848520	·297163	3·365156	·9585715	27	53	·2904239	·303505	3·294833	·9568981	7
13	·2792704	·290842	3·438289	·9602125	47	34	·2851308	·297479	3·361575	·9584886	26	54	·2907022	·303823	3·291387	·9568136	6
14	·2795497	·291157	3·434563	·9601312	46	35	·2854096	·297796	3·358000	·9584056	25	55	·2909805	·304141	3·287948	·9567290	5
15	·2798290	·291473	3·430844	·9600499	45	36	·2856884	·298112	3·354433	·9583226	24	56	·2912588	·304458	3·284516	·9566443	4
16	·2801083	·291789	3·427133	·9599684	44	37	·2859671	·298429	3·350872	·9582394	23	57	·2915371	·304776	3·281090	·9565595	3
17	·2803875	·292104	3·423429	·9598869	43	38	·2862458	·298746	3·347319	·9581562	22	58	·2918153	·305094	3·277671	·9564747	2
18	·2806667	·292420	3·419733	·9598053	42	39	·2865246	·299063	3·343772	·9580729	21	59	·2920935	·305412	3·274258	·9563898	1
19	·2809459	·292736	3·416044	·9597236	41	40	·2868032	·299380	3·340232	·9579895	20	60	·2923717	305730	3·270852	·9563048	0
20	·2812251	·293052	3·412362	·9596418	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 73. Deg. 73. Deg. 73.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

17 Deg. 17 Deg. 17 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·2923717	·305730	3·270852	·9563048	60	21	·2982079	·312422	3·200789	·9545009	39	41	·3037559	·318820	3·136563	·9527499	19
1	·2926499	·306048	3·267452	·9562197	59	22	·2984856	·312742	3·197521	·9544141	38	42	·3040331	·319140	3·133414	·9526615	18
2	·2929280	·306367	3·264059	·9561345	58	23	·2987632	·313061	3·194259	·9543273	37	43	·3043102	·319461	3·130270	·9525730	17
3	·2932061	·306685	3·260672	·9560492	57	24	·2990408	·313381	3·191003	·9542403	36	44	·3045872	·319781	3·127131	·9524844	16
4	·2934842	·307003	3·257292	·9559639	56	25	·2993184	·313700	3·187754	·9541533	35	45	·3048643	·320102	3·123999	·9523958	15
5	·2937623	·307321	3·253918	·9558785	55	26	·2995959	·314020	3·184510	·9540662	34	46	·3051413	·320423	3·120872	·9523071	14
6	·2940403	·307640	3·250550	·9557930	54	27	·2998734	·314339	3·181272	·9539790	33	47	·3054183	·320744	3·117750	·9522183	13
7	·2943183	·307958	3·247189	·9557074	53	28	·3001509	·314659	3·178040	·9538917	32	48	·3056953	·321064	3·114635	·9521294	12
8	·2945963	·308277	3·243834	·9556218	52	29	·3004284	·314979	3·174814	·9538044	31	49	·3059723	·321385	3·111525	·9520404	11
9	·2948743	·308595	3·240486	·9555361	51	30	·3007058	·315298	3·171594	·9537170	30	50	·3062492	·321706	3·108421	·9519514	10
10	·2951522	·308914	3·237143	·9554502	50	31	·3009832	·315618	3·168380	·9536294	29	51	·3065261	·322027	3·105322	·9518623	9
11	·2954302	·309233	3·233807	·9553643	49	32	·3012606	·315938	3·165172	·9535418	28	52	·3068030	·322348	3·102229	·9517731	8
12	·2957081	·309551	3·230478	·9552784	48	33	·3015380	·316258	3·161970	·9534542	27	53	·3070798	·322670	3·099141	·9516838	7
13	·2959859	·309870	3·227154	·9551923	47	34	·3018153	·316578	3·158774	·9533664	26	54	·3073566	·322991	3·096059	·9515944	6
14	·2962638	·310189	3·223837	·9551062	46	35	·3020926	·316898	3·155584	·9532786	25	55	·3076334	·323312	3·092983	·9515050	5
15	·2965416	·310508	3·220526	·9550199	45	36	·3023699	·317218	3·152399	·9531907	24	56	·3079102	·323633	3·089912	·9514154	4
16	·2968194	·310827	3·217221	·9549336	44	37	·3026471	·317538	3·149220	·9531027	23	57	·3081869	·323955	3·086846	·9513258	3
17	·2970971	·311146	3·213922	·9548473	43	38	·3029244	·317859	3·146047	·9530146	22	58	·3084636	·324276	3·083786	·9512361	2
18	·2973749	·311465	3·210630	·9547608	42	39	·3032016	·318179	3·142880	·9529264	21	59	·3087403	·324598	3·080732	·9511464	1
19	·2976526	·311784	3·207344	·9546743	41	40	·3034788	·318499	3·139719	·9528382	20	60	·3090170	·324919	3·077683	·9510565	0
20	·2979303	·312103	3·204063	·9545876	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 72. Deg. 72. Deg. 72.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

18 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3090170	·324919	3·077683	·9500565	60
1	·3092936	·325241	3·074640	·9509666	59
2	·3095702	·325563	3·071602	·9508766	58
3	·3098468	·325884	3·068569	·9507865	57
4	·3101234	·326206	3·065542	·9506963	56
5	·3103999	·326528	3·062520	·9506061	55
6	·3106764	·326850	3·059503	·9505157	54
7	·3109529	·327172	3·056492	·9504253	53
8	·3112294	·327494	3·053487	·9503348	52
9	·3115058	·327816	3·050486	·9502443	51
10	·3117822	·328138	3·047491	·9501536	50
11	·3120586	·328461	3·044501	·9500629	49
12	·3123349	·328783	3·041517	·9499721	48
13	·3126112	·329105	3·038538	·9498812	47
14	·3128875	·329428	3·035564	·9497902	46
15	·3131638	·329750	3·032595	·9496991	45
16	·3134400	·330073	3·029632	·9496080	44
17	·3137163	·330395	3·026673	·9495168	43
18	·3139925	·330718	3·023720	·9494255	42
19	·3142686	·331041	3·020772	·9493341	41
20	·3145448	·331363	3·017830	·9492426	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 71.

18 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·3148209	·331686	3·014892	·9491511	39
22	·3150969	·332009	3·011960	·9490595	38
23	·3153730	·332332	3·009033	·9489678	37
24	·3156490	·332655	3·006110	·9488760	36
25	·3159250	·332978	3·003193	·9487842	35
26	·3162010	·333302	3·000282	·9486922	34
27	·3164770	·333625	2·997375	·9486002	33
28	·3167529	·333948	2·994473	·9485081	32
29	·3170288	·334271	2·991576	·9484159	31
30	·3173047	·334595	2·988685	·9483237	30
31	·3175805	·334918	2·985798	·9482313	29
32	·3178563	·335242	2·982916	·9481389	28
33	·3181321	·335566	2·980040	·9480464	27
34	·3184079	·335889	2·977168	·9479538	26
35	·3186836	·336213	2·974301	·9478612	25
36	·3189593	·336537	2·971439	·9477684	24
37	·3192350	·336861	2·968583	·9476756	23
38	·3195106	·337185	2·965731	·9475827	22
39	·3197863	·337509	2·962884	·9474897	21
40	·3200619	·337833	2·960042	·9473966	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 71.

18 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·3203374	·338157	2·957205	·9473035	19
42	·3206130	·338481	2·954372	·9472103	18
43	·3208885	·338805	2·951545	·9471170	17
44	·3211640	·339129	2·948722	·9470236	16
45	·3214395	·339454	2·945905	·9469301	15
46	·3217149	·339778	2·943092	·9468366	14
47	·3219903	·340103	2·940284	·9467430	13
48	·3222657	·340427	2·937480	·9466493	12
49	·3225411	·340752	2·934682	·9465555	11
50	·3228164	·341077	2·931888	·9464616	10
51	·3230917	·341401	2 929099	·9463677	9
52	·3233670	·341726	2·926315	·9462736	8
53	·3236422	·342051	2·923535	·9461795	7
54	·3239174	·342376	2·920761	·9460854	6
55	·3241926	·342701	2·917990	·9459911	5
56	·3244678	·343026	2·915225	·9458968	4
57	·3247429	·343351	2·912464	·9458023	3
58	·3250180	·343677	2·909708	·9457078	2
59	·3252931	·344002	2·906957	·9456132	1
60	·3255682	·344327	2·904211	·9455186	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 71.

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	60
[illegible]	[illegible]	[illegible]	2 901168	[illegible]	59
[illegible]	[illegible]	[illegible]	[illegible]	9153290	58
[illegible]	[illegible]	[illegible]	2 895906	9152311	57
[illegible]	[illegible]	315529	2 893270	9151391	56
[illegible]	[illegible]	315955	2 890546	[illegible]	55
[illegible]	3272179	316281	[illegible]	[illegible]	54
[illegible]	3274928	316606	[illegible]	[illegible]	53
8	3277676	316932	[illegible]	[illegible]	52
9	3280421	317256	2 879097	[illegible]	51
10	3283172	[illegible]	[illegible]	[illegible]	50
11	3285919	317910	[illegible]	[illegible]	49
12	3288666	318236	[illegible]	[illegible]	48
13	3291413	318565	2 860921	[illegible]	47
14	3294160	318909	[illegible]	[illegible]	46
15	3296906	319215	[illegible]	[illegible]	45
16	3299653	319542	[illegible]	[illegible]	44
17	3302398	319868	[illegible]	[illegible]	43
18	3305144	[illegible]	[illegible]	[illegible]	42
19	3307889	[illegible]	[illegible]	[illegible]	41
20	3310634	[illegible]	[illegible]	[illegible]	40
′	Cosine	Cotan	Tang	Sine	

Deg [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Deg [illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Deg [illegible]

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

20 Deg. 20 Deg. 20 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3420201	·363970	2·747477	·9396926	60	21	·3477540	·370903	2·696118	·9375858	39	41	·3532027	·377536	2·648753	·9355468	19
1	·3422935	·364299	2·744992	·9395931	59	22	·3480267	·371234	2·693714	·9374846	38	42	·3534748	·377868	2·646423	·9354440	18
2	·3425668	·364629	2·742512	·9394935	58	23	·3482994	·371565	2·691314	·9373833	37	43	·3537469	·378201	2·644096	·9353412	17
3	·3428400	·364958	2·740035	·9393938	57	24	·3485720	·371896	2·688919	·9372820	36	44	·3540190	·378533	2·641774	·9352382	16
4	·3431133	·365288	2·737562	·9392940	56	25	·3488447	·372227	2·686526	·9371806	35	45	·3542910	·378866	2·639454	·9351352	15
5	·3433865	·365618	2·735093	·9391942	55	26	·3491173	·372559	2·684138	·9370790	34	46	·3545630	·379198	2·637139	·9350321	14
6	·3436597	·365948	2·732628	·9390943	54	27	·3493898	·372890	2·681753	·9369774	33	47	·3548350	·379531	2·634827	·9349289	13
7	·3439329	·366277	2·730167	·9389943	53	28	·3496624	·373221	2·679372	·9368758	32	48	·3551070	·379864	2·632518	·9348257	12
8	·3442060	·366607	2·727710	·9388942	52	29	·3499349	·373553	2·676995	·9367740	31	49	·3553789	·380197	2·630213	·9347223	11
9	·3444791	·366937	2·725256	·9387940	51	30	·3502074	·373884	2·674621	·9366722	30	50	·3556508	·380530	2·627912	·9346189	10
10	·3447521	·367268	2·722807	·9386938	50	31	·3504798	·374216	2·672251	·9365703	29	51	·3559226	·380863	2·625614	·9345154	9
11	·3450252	·367598	2·720362	·9385934	49	32	·3507523	·374547	2·669885	·9364683	28	52	·3561944	·381196	2·623319	·9344119	8
12	·3452982	·367928	2·717920	·9384930	48	33	·3510246	·374879	2·667522	·9363662	27	53	·3564662	·381529	2·621028	·9343082	7
13	·3455712	·368258	2·715482	·9383925	47	34	·3512970	·375211	2·665163	·9362641	26	54	·3567380	·381862	2·618741	·9342045	6
14	·3458441	·368589	2·713048	·9382920	46	35	·3515693	·375543	2·662808	·9361618	25	55	·3570097	·382196	2·616457	·9341007	5
15	·3461171	·368919	2·710618	·9381913	45	36	·3518416	·375875	2·660456	·9360595	24	56	·3572814	·382529	2·614176	·9339968	4
16	·3463900	·369250	2·708192	·9380906	44	37	·3521139	·376207	2·658108	·9359571	23	57	·3575531	·382863	2·611899	·9338928	3
17	·3466628	·369580	2·705769	·9379898	43	38	·3523862	·376539	2·655764	·9358547	22	58	·3578248	·383196	2·609625	·9337888	2
18	·3469357	·369911	2·703351	·9378889	42	39	·3526584	·376871	2·653423	·9357521	21	59	·3580964	·383530	2·607355	·9336846	1
19	·3472085	·370242	2·700936	·9377880	41	40	·3529306	·377203	2·651086	·9356495	20	60	·3583679	·383864	2·605089	·9335804	0
20	·3474812	·370572	2·698525	·9376869	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 69. Deg. 69. Deg. 69.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

21 Deg. 21 Deg. 21 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3583679	·383864	2·605089	·9335804	60	21	·3640641	·390889	2·558268	·9313739	39	41	·3694765	·397611	2·515018	·9291401	19
1	·3586395	·384197	2·602825	·9334761	59	22	·3643351	·391224	2·556075	·9312679	38	42	·3697468	·397948	2·512889	·9291326	18
2	·3589110	·384531	2·600565	·9333718	58	23	·3646059	·391560	2·553885	·9311619	37	43	·3700170	·398285	2·510762	·9290250	17
3	·3591825	·384865	2·598309	·9332673	57	24	·3648768	·391895	2·551699	·9310558	36	44	·3702872	·398622	2·508639	·9289173	16
4	·3594540	·385199	2·596056	·9331628	56	25	·3651476	·392231	2·549516	·9309496	35	45	·3705574	·398959	2·506519	·9288096	15
5	·3597254	·385533	2·593806	·9330582	55	26	·3654184	·392567	2·547335	·9308434	34	46	·3708276	·399296	2·504402	·9287017	14
6	·3599968	·385867	2·591560	·9329535	54	27	·3656891	·392902	2·545159	·9307370	33	47	·3710977	·399634	2·502289	·9285938	13
7	·3602682	·386202	2·589317	·9328488	53	28	·3659599	·393238	2·542985	·9306306	32	48	·3713678	·399971	2·500178	·9284858	12
8	·3605395	·386536	2·587078	·9327439	52	29	·3662306	·393574	2·540815	·9305241	31	49	·3716379	·400308	2·498070	·9283778	11
9	·3608108	·386870	2·584842	·9326390	51	30	·3665012	·393910	2·538647	·9304176	30	50	·3719079	·400646	2·495966	·9282696	10
10	·3610821	·387205	2·582609	·9325340	50	31	·3667719	·394246	2·536483	·9303109	29	51	·3721780	·400984	2·493864	·9281614	9
11	·3613534	·387539	2·580380	·9324290	49	32	·3670425	·394582	2·534323	·9302042	28	52	·3724479	·401321	2·491766	·9280531	8
12	·3616246	·387874	2·578153	·9323238	48	33	·3673130	·394918	2·532165	·9300974	27	53	·3727179	·401659	2·489670	·9279447	7
13	·3618958	·388209	2·575931	·9322186	47	34	·3675836	·395255	2·530011	·9299905	26	54	·3729878	·401997	2·487578	·9278363	6
14	·3621669	·388543	2·573711	·9321133	46	35	·3678541	·395591	2·527859	·9298835	25	55	·3732577	·402335	2·485488	·9277277	5
15	·3624380	·388878	2·571495	·9320079	45	36	·3681246	·395928	2·525711	·9297765	24	56	·3135275	·402673	2·483402	·9276191	4
16	·3627091	·389213	2·569283	·9319024	44	37	·3683950	·396264	2·523566	·9296694	23	57	·3737973	·403011	2·481319	·9275104	3
17	·3629802	·389548	2·567073	·9317969	43	38	·3686654	·396601	2·521424	·9295622	22	58	·3740671	·403349	2·479238	·9274016	2
18	·3632512	·389883	2·564867	·9316912	42	39	·3689358	·396937	2·519286	·9294549	21	59	·3743369	·403687	2·477161	·9272928	1
19	·3635222	·390218	2·562664	·9315855	41	40	·3692061	·397274	2·517150	·9293475	20	60	·3746066	·404026	2·475086	·9271839	0
20	·3637932	·390554	2·560464	·9314797	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 68. Deg. 68. Deg. 68.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

22 Deg. 22 Deg. 22 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3746066	·404026	2·475086	·9271839	60	21	·3802634	·411149	2·432204	·9248782	39	41	·3856377	·417967	2·392531	·9226503	19
1	·3748763	·404364	2·473015	·9270748	59	22	·3805324	·411489	2·430193	·9247676	38	42	·3859060	·418309	2·390576	·9225381	18
2	·3751459	·404703	2·470947	·9269658	58	23	·3808014	·411830	2·428186	·9246568	37	43	·3861744	·418650	2·388625	·9224258	17
3	·3754156	·405041	2·468881	·9268566	57	24	·3810704	·412170	2·426181	·9245460	36	44	·3864427	·418992	2·386675	·9223134	16
4	·3756852	·405380	2·466819	·9267474	56	25	·3813393	·412510	2·424180	·9244351	35	45	·3867110	·419334	2·384729	·9222010	15
5	·3759547	·405719	2·464759	·9266380	55	26	·3816082	·412851	2·422181	·9243242	34	46	·3869792	·419676	2·382785	·9220884	14
6	·3762243	·406057	2·462703	·9265286	54	27	·3818770	·413191	2·420185	·9242131	33	47	·3872474	·420019	2·380844	·9219758	13
7	·3764938	·406396	2·460649	·9264192	53	28	·3821459	·413532	2·418191	·9241020	32	48	·3875156	·420361	2·378906	·9218632	12
8	·3767632	·406735	2·458598	·9263096	52	29	·3824147	·413872	2·416201	·9239908	31	49	·3877837	·420703	2·376970	·9217504	11
9	·3770327	·407074	2·456551	·9262000	51	30	·3826834	·414213	2·414213	·9238795	30	50	·3880518	·421046	2·375037	·9216375	10
10	·3773021	·407413	2·454506	·9260902	50	31	·3829522	·414554	2·412228	·9237682	29	51	·3883199	·421388	2·373106	·9215246	9
11	·3775714	·407753	2·452464	·9259805	49	32	·3832209	·414895	2·410246	·9236567	28	52	·3885880	·421731	2·371179	·9214116	8
12	·3778408	·408092	2·450425	·9258706	48	33	·3834895	·415236	2·408267	·9235452	27	53	·3888560	·422073	2·369254	·9212986	7
13	·3781101	·408431	2·448389	·9257606	47	34	·3837582	·415577	2·406290	·9234336	26	54	·3891240	·422416	2 367331	·9211854	6
14	·3783794	·408771	2·446355	·9256506	46	35	·3840268	·415918	2·404316	·9233220	25	55	·3893919	·422759	2 365411	·9210722	5
15	·3786486	·409110	2·444325	·9255405	45	36	·3842953	·416259	2·402345	·9232102	24	56	·3896598	·423102	2·363494	·9209589	4
16	·3789178	·409450	2·442298	·9254303	44	37	·3845639	·416601	2·400377	·9230984	23	57	·3899277	·423445	2·361580	·9208455	3
17	·3791870	·409790	2·440273	·9253201	43	38	·3848324	·416942	2·398411	·9229865	22	58	·3901955	·423788	2 359668	·9207320	2
18	·3794562	·410129	2·438251	·9252097	42	39	·3851008	·417284	2·396449	·9228745	21	59	·3904633	·424131	2·357759	·9206185	1
19	·3797253	·410469	2·436233	·9250993	41	40	·3853693	·417625	2 394488	·9227624	20	60	·3907311	·424474	2·355852	·9205049	0
20	·3799944	·410809	2·434217	·9249888	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 67. Deg. 67. Deg. 67.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

23 Deg. 23 Deg. 23 Deg

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3907311	·424474	2·355852	·9205049	60	21	·3963468	·431703	2·316407	·9181009	39	41	·4016814	·438622	2·279865	·9157795	19
1	·3909989	·424818	2·353948	·9203912	59	22	·3966139	·432048	2·314557	·9179855	38	42	·4019478	·438969	2·278063	·9156626	18
2	·3912666	·425161	2·352046	·9202774	58	23	·3968809	·432393	2·312709	·9178701	37	43	·4022141	·439316	2·276264	·9155456	17
3	·3915343	·425505	2·350148	·9201635	57	24	·3971479	·432738	2·310863	·9177546	36	44	·4024804	·439663	2·274467	·9154286	16
4	·3918019	·425848	2·348251	·9200496	56	25	·3974148	·433084	2·309020	·9176391	35	45	·4027467	·440010	2·272672	·9153115	15
5	·3920695	·426192	2·346358	·9199356	55	26	·3976818	·433429	2·307180	·9175234	34	46	·4030129	·440357	2·270880	·9151943	14
6	·3923371	·426536	2·344467	·9198215	54	27	·3979486	·433775	2·305342	·9174077	33	47	·4032791	·440705	2·269090	·9150770	13
7	·3926047	·426880	2·342578	·9197073	53	28	·3982155	·434120	2·303506	·9172919	32	48	·4035453	·441052	2·267303	·9149597	12
8	·3928722	·427223	2·340692	·9195931	52	29	·3984823	·434466	2·301673	·9171760	31	49	·4038114	·441400	2·265518	·9148422	11
9	·3931397	·427568	2·338809	·9194788	51	30	·3987491	·434812	2·299842	·9170601	30	50	·4040775	·441747	2·263735	·9147247	10
10	·3934071	·427912	2·336928	·9193644	50	31	·3990158	·435158	2·298014	·9169440	29	51	·4043436	·442095	2·261955	·9146072	9
11	·3936745	·428256	2·335050	·9192499	49	32	·3992825	·435504	2·296188	·9168279	28	52	·4046096	·442443	2·260177	·9144895	8
12	·3939419	·428600	2·333174	·9191353	48	33	·3995492	·435850	2·294365	·9167118	27	53	·4048756	·442791	2·258401	·9143718	7
13	·3942093	·428944	2·331301	·9190207	47	34	·3998158	·436196	2·292544	·9165955	26	54	·4051416	·443139	2·256628	·9142540	6
14	·3944766	·429289	2·329431	·9189060	46	35	·4000825	·436542	2·290725	·9164791	25	55	·4054075	·443487	2·254857	·9141361	5
15	·3947439	·429633	2·327563	·9187912	45	36	·4003490	·436889	2·288909	·9163627	24	56	·4056734	·443835	2·253088	·9140181	4
16	·3950111	·429978	2·325697	·9186763	44	37	·4006156	·437235	2·287095	·9162462	23	57	·4059393	·444183	2·251322	·9139001	3
17	·3952783	·430323	2·323834	·9185614	43	38	·4008821	·437582	2·285284	·9161297	22	58	·4062051	·444531	2·249558	·9137819	2
18	·3955455	·430668	2·321974	·9184464	42	39	·4011486	·437928	2·283475	·9160130	21	59	·4064709	·444880	2·247796	·9136637	1
19	·3958127	·431012	2·320116	·9183313	41	40	·4014150	·438275	2·281669	·9158963	20	60	·4067366	·445228	2·246036	·9135455	0
20	·3960798	·431357	2·318260	·9182161	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 66. Deg. 66. Deg. 66.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

24 Deg.						24 Deg.						24 Deg.					
′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4067366	·445228	2·246036	·9135455	60	21	·4123096	·452568	2·209611	·9110438	39	41	·4176028	·459596	2·175822	·9086297	19
1	·4070024	·445577	2·244279	·9134271	59	22	·4125745	·452918	2·207901	·9109238	38	42	·4178671	·459948	2·174155	·9085082	18
2	·4072681	·445926	2·242524	·9133087	58	23	·4128395	·453269	2·206193	·9108038	37	43	·4181313	·460301	2·172491	·9083866	17
3	·4075337	·446274	2·240772	·9131902	57	24	·4131044	·453620	2·204487	·9106837	36	44	·4183956	·460653	2·170828	·9082649	16
4	·4077993	·446623	2·239021	·9130716	56	25	·4133693	·453970	2·202784	·9105635	35	45	·4186597	·461006	2·169167	·9081432	15
5	·4080649	·446972	2·237273	·9129529	55	26	·4136342	·454321	2·201083	·9104432	34	46	·4189239	·461359	2·167509	·9080214	14
6	·4083305	·447321	2·235528	·9128342	54	27	·4138990	·454672	2·199384	·9103228	33	47	·4191880	·461711	2·165852	·9078995	13
7	·4085960	·447670	2·233784	·9127154	53	28	·4141638	·455023	2·197687	·9102024	32	48	·4194521	·462064	2·164198	·9077775	12
8	·4088615	·448020	2·232043	·9125965	52	29	·4144285	·455375	2·195992	·9100819	31	49	·4197161	·462417	2·162546	·9076554	11
9	·4091269	·448369	2·230304	·9124775	51	30	·4146932	·455726	2·194299	·9099613	30	50	·4199801	·462771	2·160895	·9075333	10
10	·4093923	·448718	2·228567	·9123584	50	31	·4149579	·456077	2·192609	·9098406	29	51	·4202441	·463124	2·159247	·9074111	9
11	·4096577	·449068	2·226833	·9122393	49	32	·4152226	·456429	2·190921	·9097199	28	52	·4205080	·463477	2·157601	·9072888	8
12	·4099230	·449417	2·225100	·9121201	48	33	·4154872	·456780	2·189234	·9095990	27	53	·4207719	·463831	2·155957	·9071665	7
13	·4101883	·449767	2·223370	·9120008	47	34	·4157517	·457132	2·187551	·9094781	26	54	·4210358	·464184	2·154315	·9070440	6
14	·4104536	·450117	2·221643	·9118815	46	35	·4160163	·457483	2·185869	·9093572	25	55	·4212966	·464538	2·152675	·9069215	5
15	·4107189	·450467	2·219917	·9117620	45	36	·4162808	·457835	2·184189	·9092361	24	56	·4215634	·464891	2·151037	·9067989	4
16	·4109841	·450817	2·218194	·9116425	44	37	·4165453	·458187	2·182511	·9091150	23	57	·4218272	·465245	2·149402	·9066762	3
17	·4112492	·451167	2·216473	·9115229	43	38	·4168097	·458539	2·180836	·9089938	22	58	·4220909	·465599	2·147768	·9065535	2
18	·4115144	·451517	2·214754	·9114033	42	39	·4170741	·458891	2.179163	·9088725	21	59	·4223546	·465953	2·146136	·9064307	1
19	·4117795	·451867	2·213037	·9112835	41	40	·4173385	·459243	2·177492	·9087511	20	60	·4226183	·466307	2·144506	·9063078	0
20	·4120445	·452217	2·211323	·9111637	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′
				Deg. 65.						Deg. 65.						Deg. 65.	

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

23 Deg. 23 Deg. 23 Deg

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·3907311	·424474	2·355852	·9205049	60	21	·3963468	·431703	2·316407	·9181009	39	41	·4016814	·438622	2·279865	·9157795	19
1	·3909989	·424818	2·353948	·9203912	59	22	·3966139	·432048	2·314557	·9179855	38	42	·4019478	·438969	2·278063	·9156626	18
2	·3912666	·425161	2·352046	·9202774	58	23	·3968809	·432393	2·312709	·9178701	37	43	·4022141	·439316	2·276264	·9155456	17
3	·3915343	·425505	2·350148	·9201635	57	24	·3971479	·432738	2·310863	·9177546	36	44	·4024804	·439663	2·274467	·9154286	16
4	·3918019	·425848	2·348251	·9200496	56	25	·3974148	·433084	2·309020	·9176391	35	45	·4027467	·440010	2·272672	·9153115	15
5	·3920695	·426192	2·346358	·9199356	55	26	·3976818	·433429	2·307180	·9175234	34	46	·4030129	·440357	2·270880	·9151943	14
6	·3923371	·426536	2·344467	·9198215	54	27	·3979486	·433775	2·305342	·9174077	33	47	·4032791	·440705	2·269090	·9150770	13
7	·3926047	·426880	2·342578	·9197073	53	28	·3982155	·434120	2·303506	·9172919	32	48	·4035453	·441052	2·267303	·9149597	12
8	·3928722	·427223	2·340692	·9195931	52	29	·3984823	·434466	2·301673	·9171760	31	49	·4038114	·441400	2·265518	·9148422	11
9	·3931397	·427568	2·338809	·9194788	51	30	·3987491	·434812	2·299842	·9170601	30	50	·4040775	·441747	2·263735	·9147247	10
10	·3934071	·427912	2·336928	·9193644	50	31	·3990158	·435158	2·298014	·9169440	29	51	·4043436	·442095	2·261955	·9146072	9
11	·3936745	·428256	2·335050	·9192499	49	32	·3992825	·435504	2·296188	·9168279	28	52	·4046096	·442443	2·260177	·9144895	8
12	·3939419	·428600	2·333174	·9191353	48	33	·3995492	·435850	2·294365	·9167118	27	53	·4048756	·442791	2·258401	·9143718	7
13	·3942093	·428944	2·331301	·9190207	47	34	·3998158	·436196	2·292544	·9165955	26	54	·4051416	·443139	2·256628	·9142540	6
14	·3944766	·429289	2·329431	·9189060	46	35	·4000825	·436542	2·290725	·9164791	25	55	·4054075	·443487	2·254857	·9141361	5
15	·3947439	·429633	2·327563	·9187912	45	36	·4003490	·436889	2·288909	·9163627	24	56	·4056734	·443835	2·253088	·9140181	4
16	·3950111	·429978	2·325697	·9186763	44	37	·4006156	·437235	2·287095	·9162462	23	57	·4059393	·444183	2·251322	·9139001	3
17	·3952783	·430323	2·323834	·9185614	43	38	·4008821	·437582	2·285284	·9161297	22	58	·4062051	·444531	2·249558	·9137819	2
18	·3955455	·430668	2·321974	·9184464	42	39	·4011486	·437928	2·283475	·9160130	21	59	·4064709	·444880	2·247796	·9136637	1
19	·3958127	·431012	2·320116	·9183313	41	40	·4014150	·438275	2·281669	·9158963	20	60	·4067366	·445228	2·246036	·9135455	0
20	·3960798	·431357	2·318260	·9182161	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 66. Deg. 66. Deg. 66.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

24 Deg. 24 Deg. 24 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4067366	·445228	2·246036	·9135455	60	21	·4123096	·452568	2·209611	·9110438	39	41	·4176028	·459596	2·175822	·9086297	19
1	·4070024	·445577	2·244279	·9134271	59	22	·4125745	·452918	2·207901	·9109238	38	42	·4178671	·459948	2·174155	·9085082	18
2	·4072681	·445926	2·242524	·9133087	58	23	·4128395	·453269	2·206193	·9108038	37	43	·4181313	·460301	2·172491	·9083866	17
3	·4075337	·446274	2·240772	·9131902	57	24	·4131044	·453620	2·204487	·9106837	36	44	·4183956	·460653	2·170828	·9082649	16
4	·4077993	·446623	2·239021	·9130716	56	25	·4133693	·453970	2·202784	·9105635	35	45	·4186597	·461006	2·169167	·9081432	15
5	·4080649	·446972	2·237273	·9129529	55	26	·4136342	·454321	2·201083	·9104432	34	46	·4189239	·461359	2·167509	·9080214	14
6	·4083305	·447321	2·235528	·9128342	54	27	·4138990	·454672	2·199384	·9103228	33	47	·4191880	·461711	2·165852	·9078995	13
7	·4085960	·447670	2·233784	·9127154	53	28	·4141638	·455023	2·197687	·9102024	32	48	·4194521	·462064	2·164198	·9077775	12
8	·4088615	·448020	2·232043	·9125965	52	29	·4144285	·455375	2·195992	·9100819	31	49	·4197161	·462417	2·162546	·9076554	11
9	·4091269	·448369	2·230304	·9124775	51	30	·4146932	·455726	2·194299	·9099613	30	50	·4199801	·462771	2·160895	·9075333	10
10	·4093923	·448718	2·228567	·9123584	50	31	·4149579	·456077	2·192609	·9098406	29	51	·4202441	·463124	2·159247	·9074111	9
11	·4096577	·449068	2·226833	·9122393	49	32	·4152226	·456429	2·190921	·9097199	28	52	·4205080	·463477	2·157601	·9072888	8
12	·4099230	·449417	2·225100	·9121201	48	33	·4154872	·456780	2·189234	·9095990	27	53	·4207719	·463831	2·155957	·9071665	7
13	·4101883	·449767	2·223370	·9120008	47	34	·4157517	·457132	2·187551	·9094781	26	54	·4210358	·464184	2·154315	·9070440	6
14	·4104536	·450117	2·221643	·9118815	46	35	·4160163	·457483	2·185869	·9093572	25	55	·4212966	·464538	2·152675	·9069215	5
15	·4107189	·450467	2·219917	·9117620	45	36	·4162808	·457835	2·184189	·9092361	24	56	·4215634	·464891	2·151037	·9067989	4
16	·4109841	·450817	2·218194	·9116425	44	37	·4165453	·458187	2·182511	·9091150	23	57	·4218272	·465245	2·149402	·9066762	3
17	·4112492	·451167	2·216473	·9115229	43	38	·4168097	·458539	2·180836	·9089938	22	58	·4220909	·465599	2·147768	·9065535	2
18	·4115144	·451517	2·214754	·9114033	42	39	·4170741	·458891	2.179163	·9088725	21	59	·4223546	·465953	2·146136	·9064307	1
19	·4117795	·451867	2·213037	·9112835	41	40	·4173385	·459243	2·177492	·9087511	20	60	·4226183	·466307	2·144506	·9063078	0
20	·4120445	·452217	2·211323	·9111637	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 65. Deg. 65. Deg. 65.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

25 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4226183	·466307	2·144506	·9063078	60
1	·4228819	·466661	2·142879	·9061848	59
2	·4231455	·467016	2·141253	·9060618	58
3	·4234090	·467370	2·139630	·9059386	57
4	·4236725	·467725	2·138008	·9058154	56
5	·4239360	·468079	2·136389	·9056922	55
6	·4241994	·468434	2·134771	·9055688	54
7	·4244628	·468789	2·133155	·9054454	53
8	·4247262	·469143	2·131542	·9053219	52
9	·4249895	·469498	2·129930	·9051983	51
10	·4252528	·469853	2·128321	·9050746	50
11	·4255161	·470209	2·126713	·9049509	49
12	·4257793	·470564	2·125108	·9048271	48
13	·4260425	·470919	2·123504	·9047032	47
14	·4263056	·471275	2·121903	·9045792	46
15	·4265687	·471630	2·120303	·9044551	45
16	·4268318	·471986	2·118705	·9043310	44
17	·4270949	·472342	2·117110	·9042068	43
18	·4273579	·472697	2·115516	·9040825	42
19	·4276208	·473053	2·113924	·9039582	41
20	·4278838	·473409	2·112334	·9038338	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 64.

25 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·4281467	·473765	2·110747	·9037093	39
22	·4284095	·474122	2·109161	·9035847	38
23	·4286723	·474478	2·107577	·9034600	37
24	·4289351	·474834	2·105995	·9033353	36
25	·4291979	·475191	2·104415	·9032105	35
26	·4294606	·475548	2·102836	·9030856	34
27	·4297233	·475904	2·101260	·9029606	33
28	·4299859	·476261	2·099686	·9028356	32
29	·4302485	·476618	2·098114	·9027105	31
30	·4305111	·476975	2·096543	·9025853	30
31	·4307736	·477332	2·094975	·9024600	29
32	·4310361	·477689	2·093408	·9023347	28
33	·4312986	·478047	2·091843	·9022092	27
34	·4315610	·478404	2·090280	·9020838	26
35	·4318234	·478762	2·088720	·9019582	25
36	·4320857	·479119	2·087161	·9018325	24
37	·4323481	·479477	2·085603	·9017068	23
38	·4326103	·479835	2·084048	·9015810	22
39	·4328726	·480193	2·082495	·9014551	21
40	·4331348	·480551	2·080943	·9013292	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 64.

25 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·4333970	·480909	2·079394	·9012031	19
42	·4336591	·481267	2·077846	·9010770	18
43	·4339212	·481625	2·076300	·9009508	17
44	·4341832	·481984	2·074755	·9008246	16
45	·4344453	·482342	2·073211	·9006982	15
46	·4347072	·482701	2·071674	·9005718	14
47	·4349692	·483060	2·070135	·9004453	13
48	·4352311	·483418	2·068599	·9003188	12
49	·4354930	·483777	2·067064	·9001921	11
50	·4357548	·484136	2·065531	·9000654	10
51	·4360166	·484495	2·064000	·8999386	9
52	·4362784	·484855	2·062471	·8998117	8
53	·4365401	·485214	2·060944	·8996848	7
54	·4368018	·485573	2·059418	·8995578	6
55	·4370634	·485933	2·057895	·8994307	5
56	·4373251	·486293	2·056373	·8993035	4
57	·4375866	·486652	2·054853	·8991763	3
58	·4378482	·487012	2·053334	·8990489	2
59	·4381097	·487372	2·051818	·8989215	1
60	·4383711	·487732	2·050303	·8987940	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 64.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

26 Deg. 26 Deg. 26 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4383711	·487732	2·050303	·8987940	60	21	·4438534	·495317	2·018908	·8960994	39	41	·4490591	·502583	1·989720	·8935021	19
1	·4386326	·488092	2·048791	·8986665	59	22	·4441140	·495679	2·017433	·8959703	38	42	·4493190	·502947	1·988278	·8933714	18
2	·4388940	·488453	2·047280	·8985389	58	23	·4443746	·496041	2·015959	·8958411	37	43	·4495789	·503312	1·986838	·8932406	17
3	·4391553	·488813	2·045770	·8984112	57	24	·4446352	·496404	2·014486	·8957118	36	44	·4498387	·503676	1·985400	·8931098	16
4	·4394166	·489173	2·044263	·8982834	56	25	·4448957	·496766	2·013016	·8955824	35	45	·4500984	·504041	1·983963	·8929789	15
5	·4396779	·489534	2·042757	·8981555	55	26	·4451562	·497129	2·011547	·8954529	34	46	·4503582	·504406	1·982528	·8928480	14
6	·4399392	·489894	2·041254	·8980276	54	27	·4454167	·497492	2·010080	·8953234	33	47	·4506179	·504771	1·981095	·8927169	13
7	·4402004	·490255	2·039751	·8978996	53	28	·4456771	·497855	2·008615	·8951938	32	48	·4508775	·505136	1·979663	·8925858	12
8	·4404615	·490616	2·038251	·8977715	52	29	·4459375	·498218	2·007151	·8950641	31	49	·4511372	·505501	1·978233	·8924546	11
9	·4407227	·490977	2·036753	·8976433	51	30	·4461978	·498581	2·005689	·8949344	30	50	·4513967	·505866	1·976805	·8923234	10
10	·4409838	·491338	2·035256	·8975151	50	31	·4464581	·498944	2·004229	·8948045	29	51	·4516563	·506232	1·975378	·8921920	9
11	·4412448	·491699	2·033761	·8973868	49	32	·4467184	·499308	2·002771	·8946746	28	52	·4519158	·506597	1·973953	·8920606	8
12	·4415059	·492061	2·032268	·8972584	48	33	·4469786	·499671	2·001314	·8945446	27	53	·4521753	·506963	1·972529	·8919291	7
13	·4417668	·492422	2·030776	·8971299	47	34	·4472388	·500035	1·999859	·8944146	26	54	·4524347	·507329	1·971107	·8917975	6
14	·4420278	·492783	2·029287	·8970014	46	35	·4474990	·500398	1·998405	·8942844	25	55	·4526941	·507694	1·969687	·8916659	5
15	·4422887	·493145	2·027799	·8968727	45	36	·4477591	·500762	1·996953	·8941542	24	56	·4529535	·508060	1·968268	·8915342	4
16	·4425496	·493507	2·026313	·8967440	44	37	·4480192	·501126	1·995503	·8940240	23	57	·4532128	·508426	1·966851	·8914024	3
17	·4428104	·493868	2·024828	·8966153	43	38	·4482792	·501490	1·994055	·8938936	22	58	·4534721	·508792	1·965436	·8912705	2
18	·4430712	·494230	2·023346	·8964864	42	39	·4485392	·501854	1·992608	·8937632	21	59	·4537313	·509159	1·964022	·8911385	1
19	·4433319	·494592	2·021865	·8963575	41	40	·4487992	·502218	1·991163	·8936326	20	60	·4539905	·509525	1·962610	·8910065	0
20	·4435927	.494954	2·020386	·8962285	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 63. Deg. 63. Deg. 63.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

27 Deg. 27 Deg. 27 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4539905	·509525	1·962610	·8910065	60	21	·4594248	·517244	1·933323	·8882166	39	41	·4645845	·524640	1·906066	·8855288	19
1	·4542497	·509891	1·961200	·8908744	59	22	·4596832	·517612	1·931945	·8880830	38	42	·4648420	·525011	1·904719	·8853936	18
2	·4545088	·510258	1·959791	·8907423	58	23	·4599415	·517981	1·930569	·8879492	37	43	·4650996	·525382	1·903373	·8852584	17
3	·4547679	·510625	1·958383	·8906100	57	24	·4601998	·518350	1·929195	·8879154	36	44	·4653571	·525754	1·902029	·8851230	16
4	·4550269	·510991	1·956978	·8904777	56	25	·4604580	·518719	1·927822	·8876815	35	45	·4656145	·526126	1·900687	·8849876	15
5	.4552859	·511358	1·955573	·8903453	55	26	·4607162	·519089	1·926451	·8875475	34	46	·4658719	·526496	1·899346	·8848522	14
6	·4555449	·511725	1·954171	·8902128	54	27	·4609744	·519458	1·925081	·8874134	33	47	·4661293	·526868	1·898006	·8847166	13
7	·4558038	·512093	1·952770	·8900803	53	28	·4612325	·519827	1·923713	·8872793	32	48	·4663866	·527240	1·896668	·8845810	12
8	·4560627	·512460	1·951371	·8899476	52	29	·4614906	·520197	1·922347	·8871451	31	49	·4666439	·527612	1·895332	·8844453	11
9	·4563216	·512827	1·949973	·8898149	51	30	·4617486	·520567	1·920982	·8870108	30	50	·4669012	·527983	1·893997	·8843095	10
10	·4565804	·513195	1·948577	·8896822	50	31	·4620066	·520936	1·919618	·8868765	29	51	·4671584	·528356	1·892663	·8841736	9
11	·4568392	·513562	1·947182	·8895493	49	32	·4622646	·521306	1·918256	·8867420	28	52	·4674156	·528728	1·891331	·8840377	8
12	·4570979	·513930	1·945789	·8894164	48	33	·4625225	·521676	1·916896	·8866075	27	53	·4676727	·529100	1·890000	·8839017	7
13	·4573566	·514298	1·944398	·8892834	47	34	·4627804	·522046	1·915537	·8864730	26	54	·4679298	·529472	1·888671	·8837656	6
14	·4576153	·514666	1·943008	·8891503	46	35	·4630382	·522417	1·914179	·8863383	25	55	·4681869	·529845	1·887343	·8836295	5
15	·4578739	·515033	1·941620	·8890171	45	36	·4632960	·522787	1·912823	·8862036	24	56	·4684439	·530217	1·886017	·8834933	4
16	·4581325	·515401	1·940233	·8888839	44	37	·4635538	·523157	1·911469	·8860688	23	57	·4687009	·530590	1·884692	·8833569	3
17	·4583910	·515770	1·938848	·8887506	43	38	·4638115	·523528	1·910116	·8859339	22	58	·4689578	·530963	1·883369	·8832206	2
18	·4586496	·516138	1·937464	·8886172	42	39	·4640692	·523899	1·908764	·8857989	21	59	·4692147	·531336	1·882047	·8830841	1
19	·4589080	·516506	1·936082	·8884838	41	40	·4643269	·524269	1·907414	·8856639	20	60	·4694716	·531709	1·880726	·8829476	0
20	·4591665	·516875	1·934702	·8883503	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 62. Deg. 62. Deg. 62.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

28 Deg. 28 Deg. 28 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4694716	·531709	1·880726	·8829476	60	21	·4748564	·539570	·1853325	·8800633	39	41	·4799683	·547106	1·827799	·8772858	19
1	·4697284	·532082	1·879407	·8828110	59	22	·4751124	·539946	·1852035	·8799251	38	42	·4802235	·547484	1·826537	·8771462	18
2	·4699852	·532455	1·878089	·8826743	58	23	·4753683	·540322	·1850747	·8797869	37	43	·4804786	·547862	1·825276	·8770064	17
3	·4702419	·532829	1·876773	·8825376	57	24	·4756242	·540698	·1849461	·8796486	36	44	·4807337	·548240	1·824017	·8768666	16
4	·4704986	·533202	1·875458	·8824007	56	25	·4758801	·541074	·1848176	·8795102	35	45	·4809888	·548618	1·822759	·8767268	15
5	·4707553	·533576	1·874145	·8822638	55	26	·4761359	·541450	·1846892	·8793717	34	46	·4812438	·548997	1·821502	·8765868	14
6	·4710119	·533950	1·872833	·8821269	54	27	·4763917	·541826	·1845609	·8792332	33	47	·4814987	·549375	1·820247	·8764468	13
7	·4712685	·534324	1·871523	·8819898	53	28	·4766474	·542202	·1844328	·8790946	32	48	·4817537	·549754	1·818993	·8763067	12
8	·4715250	·534698	1·870214	·8818527	52	29	·4769031	·542579	·1843049	·8789559	31	49	·4820086	·550133	1·817740	·8761665	11
9	·4717815	·535072	1·868906	·8817155	51	30	·4771588	·542955	·1841770	·8788171	30	50	·4822634	·550512	1·816489	·8760263	10
10	·4720380	·535446	1·867600	·8815782	50	31	·4774144	·543332	·1840494	·8786783	29	51	·4825182	·550891	1·815239	·8758859	9
11	·4722944	·535820	1·866295	·8814409	49	32	·4776700	·543709	·1839218	·8785394	28	52	·4827730	·551270	1·813990	·8757455	8
12	·4725508	·536195	1·864992	·8813035	48	33	·4779255	·544086	·1837944	·8784004	27	53	·4830277	·551650	1·812743	·8756051	7
13	·4728071	·536569	1·863690	·8811660	47	34	·4781810	·544463	·1836671	·8782613	26	54	·4832824	·552029	1·811496	·8754645	6
14	·4730634	·536944	1·862389	·8810284	46	35	·4784364	·544840	·1835399	·8781222	25	55	·4835370	·552409	1·810252	·8753239	5
15	·4733197	·537319	1·861090	·8808907	45	36	·4786919	·545217	·1834129	·8779830	24	56	·4837916	·552789	1·809008	·8751832	4
16	·4735759	·537694	1·859792	·8807530	44	37	·4789472	·545595	·1832861	·8778437	23	57	·4840462	·553168	1·807766	·8750425	3
17	·4738321	·538069	1·858496	·8806152	43	38	·4792026	·545972	·1831593	·8777043	22	58	·4843007	·553548	1·806525	·8749016	2
18	·4740882	·538444	1·857201	·8804774	42	39	·4794579	·546350	·1830327	·8775649	21	59	·4845552	·553928	1·805286	·8747607	1
19	·4743443	·538819	1·855908	·8803394	41	40	·4797131	·546728	·1829062	·8774254	20	60	·4848096	·554309	1·804047	·8746197	0
20	·4746004	·539195	1·854615	·8802014	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 61. Deg. 61. Deg. 61.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

29 Deg. 29 Deg. 29 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·4848096	·554309	1·804047	·8746197	60	21	·4901433	·562321	1·778340	·8716419	39	41	·4952060	·570004	1·754372	·8687756	19
1	·4850640	·554689	1·802810	·8744786	59	22	·4903968	·562704	1·777130	·8714993	38	42	·4954587	·570389	1·753186	·8686315	18
2	·4853184	·555069	1·801575	·8743375	58	23	·4906503	·563087	1·775921	·8713566	37	43	·4957113	·570775	1·752002	·8684874	17
3	·4855727	·555450	1·800340	·8741963	57	24	·4909038	·563471	1·774714	·8712138	36	44	·4959639	·571161	1·750819	·8683431	16
4	·4858270	·555831	1·799107	·8740550	56	25	·4911572	·563854	1·773507	·8710710	35	45	·4962165	·571547	1·749637	·8681988	15
5	·4860812	·556211	1·797875	·8739137	55	26	·4914105	·564237	1·772302	·8709281	34	46	·4964690	·571933	1·748456	·8680544	14
6	·4863354	·556592	1·796645	·8737722	54	27	·4916638	·564621	1·771098	·8707851	33	47	·4967215	·572319	1·747276	·8679100	13
7	·4865895	·556973	1·795416	·8736307	53	28	·4919171	·565005	1·769895	·8706420	32	48	·4969740	·572705	1·746098	·8677655	12
8	·4868436	·557355	1·794188	·8734891	52	29	·4921704	·565388	1·768694	·8704989	31	49	·4972264	·573091	1·744921	·8676209	11
9	·4870977	·557736	1·792961	·8733475	51	30	·4924236	·565772	1·767494	·8703557	30	50	·4974787	·573478	1·743745	·8674762	10
10	·4873517	·558117	1·791736	·8732058	50	31	·4926767	·566156	1·766295	·8702124	29	51	·4977310	·573864	1·742570	·8673314	9
11	·4876057	·558499	1·790512	·8730640	49	32	·4929298	·566541	1·765097	·8700691	28	52	·4979833	·574251	1·741396	·8671866	8
12	·4878597	·558881	1·789289	·8729221	48	33	·4931829	·566925	1·763900	·8699256	27	53	·4982355	·574638	1·740224	·8670417	7
13	·4881136	·559262	1·788067	·8727801	47	34	·4934359	·567309	1·762705	·8697821	26	54	·4984877	·575025	1·739053	·8668967	6
14	·4883674	·559644	1·786847	·8726381	46	35	·4936889	·567694	1·761511	·8696386	25	55	·4987399	·575412	1·737883	·8667517	5
15	·4886212	·560026	1·785628	·8724960	45	36	·4939419	·568079	1·760318	·8694949	24	56	·4989920	·575799	1·736714	·8666066	4
16	·4888750	·560409	1·784410	·8723538	44	37	·4941948	·568463	1·759126	·8693512	23	57	·4992441	·576187	1·735546	·8664614	3
17	·4891288	·560791	1·783194	·8722116	43	38	·4944476	·568848	1·757936	·8692074	22	58	·4994961	·576574	1·734380	·8663161	2
18	·4893825	·561173	1·781979	·8720693	42	39	·4947005	·569233	1·756747	·8690636	21	59	·4997481	·576962	1·733214	·8661708	1
19	·4896361	·561556	1·780765	·8719269	41	40	·4949532	·569619	1·755559	·8689196	20	60	·5000000	·577350	1·732050	·8660254	0
20	·4898897	·561939	1·779552	·8717844	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 60. Deg. 60. Deg. 60.

IV.—Natural Sines and Tangents to a Radius 1—*continued*.

30 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5000000	·577350	1·732050	·8660254	60
1	·5002519	·577738	1·730887	·8658799	59
2	·5005037	·578126	1·729726	·8657344	58
3	·5007556	·578514	1·728565	·8655887	57
4	·5010073	·578902	1·727406	·8654430	56
5	·5012591	·579291	1·726247	·8652973	55
6	·5015107	·579679	1·725090	·8651514	54
7	·5017624	·580068	1·723934	·8650055	53
8	·5020140	·580457	1·722779	·8648595	52
9	·5022655	·580846	1·721626	·8647134	51
10	·5025170	·581235	1·720473	·8645673	50
11	·5027685	·581624	1·719322	·8644211	49
12	·5030199	·582013	1·718172	·8642748	48
13	·5032713	·582403	1·717023	·8641284	47
14	·5035227	·582793	1·715875	·8639820	46
15	·5037740	·583182	1·714728	·8638355	45
16	·5040252	·583572	1·713582	·8636889	44
17	·5042765	·583962	1·712438	·8635423	43
18	·5045276	·584352	1·711294	·8633956	42
19	·5047788	·584743	1·710152	·8632488	41
20	·5050298	·585133	1·709011	·8631019	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 59.

30 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·5052809	·585524	1·707871	·8629549	39
22	·5055319	·585914	1·706732	·8628079	38
23	·5057828	·586305	1·705595	·8626608	37
24	·5060338	·586696	1·704458	·8625137	36
25	·5062846	·587087	1·703323	·8623664	35
26	·5065355	·587478	1·702189	·8622191	34
27	·5067863	·587870	1·701055	·8620717	33
28	·5070370	·588261	1·699923	·8619243	32
29	·5072877	·588653	1·698792	·8617768	31
30	·5075384	·589045	1·697663	·8616292	30
31	·5077890	·589436	1·696534	·8614815	29
32	·5080396	·589828	1·695406	·8613337	28
33	·5082901	·590221	1·694280	·8611859	27
34	·5085406	·590613	1·693155	·8610380	26
35	·5087910	·591005	1·692030	·8608901	25
36	·5090414	·591398	1·690907	·8607420	24
37	·5092918	·591791	1·689785	·8605939	23
38	·5095421	·592183	1·688664	·8604457	22
39	·5097924	·592576	1·687544	·8602975	21
40	·5100426	·592969	1·686426	·8601491	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 59.

30 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·5102928	·593363	1·685308	·8600007	19
42	·5105429	·593756	1·684191	·8598523	18
43	·5107930	·594150	1·683076	·8597037	17
44	·5110431	·594543	1·681962	·8595551	16
45	·5112931	·594937	1·680848	·8594064	15
46	·5115431	·595331	1·679736	·8592576	14
47	·5117930	·595725	1·678625	·8591088	13
48	·5120429	·596119	1·677515	·8589599	12
49	·5122927	·596514	1·676406	·8588109	11
50	·5125425	·596908	1·675298	·8586619	10
51	·5127923	·597303	1·674192	·8585127	9
52	·5130420	·597697	1·673086	·8583635	8
53	·5132916	·598092	1·671981	·8582143	7
54	·5135413	·598487	1·670878	·8580649	6
55	·5137908	·598882	1·669775	·8579155	5
56	·5140404	·599278	1·668674	·8577660	4
57	·5142899	·599673	1·667574	·8576164	3
58	·5145393	·600069	1·666474	·8574668	2
59	·5147887	·600464	1·665376	·8573171	1
60	·5150381	·600860	1·664279	·8571673	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 59.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

31 Deg.

31 Deg.

31 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5150381	·600860	1·664279	·8571673	60	21	·5202646	·609205	1·641482	·8540051	39	41	·5252241	·617210	1·620192	·8509639	19
1	·5152874	·601256	1·663183	·8570174	59	22	·5205130	·609604	1·640408	·8538538	38	42	·5254717	·617612	1·619138	·8508111	18
2	·5155367	·601652	1·662088	·8568675	58	23	·5207613	·610003	1·639335	·8537023	37	43	·5257191	·618014	1·618085	·8506582	17
3	·5157859	·602049	1·660994	·8567175	57	24	·5210096	·610402	1·638263	·8535508	36	44	·5259665	·618416	1·617033	·8505053	16
4	·5160351	·602445	1·659901	·8565674	56	25	·5212579	·610801	1·637191	·8533992	35	45	·5262139	·618818	1·615982	·8503522	15
5	·5162842	·602841	1·658809	·8564173	55	26	·5215061	·611201	1·636121	·8532475	34	46	·5264613	·619221	1·614932	·8501991	14
6	·5165333	·603238	1·657718	·8562671	54	27	·5217543	·611601	1·635052	·8530958	33	47	·5267085	·619623	1·613882	·8500459	13
7	·5167824	·603635	1·656629	·8561168	53	28	·5220024	·612000	1·633984	·8529440	32	48	·5269558	·620026	1·612834	·8498927	12
8	·5170314	·604032	1·655540	·8559664	52	29	·5222505	·612400	1·632917	·8527921	31	49	·5272030	·620429	1·611787	·8497394	11
9	·5172804	·604429	1·654452	·8558160	51	30	·5224986	·612800	1·631851	·8526402	30	50	·5274502	·620832	1·610741	·8495860	10
10	·5175293	·604826	1·653366	·8556655	50	31	·5227466	·613201	1·630786	·8524881	29	51	·5276973	·621235	1·609696	·8494325	9
11	·5177782	·605224	1·652280	·8555149	49	32	·5229945	·613601	1·629722	·8523360	28	52	·5279443	·621638	1·608652	·8492790	8
12	·5180270	·605621	1·651196	·8553643	48	33	·5232424	·614001	1·628659	·8521839	27	53	·5281914	·622041	1·607609	·8491254	7
13	·5182758	·606019	1·650112	·8552135	47	34	·5234903	·614402	1·627597	·8520316	26	54	·5284383	·622445	1·606567	·8489717	6
14	·5185246	·606417	1·649030	·8550627	46	35	·5237381	·614803	1·626536	·8518793	25	55	·5286853	·622848	1·605526	·8488179	5
15	·5187733	·606814	1·647949	·8549119	45	36	·5239859	·615204	1·625476	·8517269	24	56	·5289322	·623252	1·604485	·8486641	4
16	·5190219	·607213	1·646868	·8547609	44	37	·5242336	·615605	1·624417	·8515745	23	57	·5291790	·623656	1·603446	·8485102	3
17	·5192705	·607611	1·645789	·8546099	43	38	·5244813	·616006	1·623359	·8514219	22	58	·5294258	·624060	1·602408	·8483562	2
18	·5195191	·608009	1·644711	·8544588	42	39	·5247290	·616407	1·622302	·8512693	21	59	·5296726	·624465	1·601370	·8482022	1
19	·5197676	·608408	1·643633	·8543077	41	40	·5249766	·616809	1·621246	·8511167	20	60	·5299193	·624869	1·600334	·8480481	0
20	·5200161	·608806	1·642557	·8541564	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 58.

Deg. 58

Deg. 58.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

32 Deg 32 Deg. 32 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5299193	·624869	1·600334	·8480481	60	21	·5350898	·633395	1·578791	·8447952	39	41	·5399955	·641577	1·558657	·8416679	19
1	·5301659	·625273	1·599299	·8478939	59	22	·5353355	·633803	1·577776	·8446395	38	42	·5402403	·641988	1·557660	·8415108	18
2	·5304125	·625678	1·598264	·8477397	58	23	·5355812	·634211	1·576761	·8444838	37	43	·5404851	·642399	1·556663	·8413536	17
3	·5306591	·626083	1·597231	·8475853	57	24	·5358268	·634619	1·575747	·8443279	36	44	·5407298	·642810	1·555668	·8411963	16
4	·5309057	·626488	1·596198	·8474309	56	25	·5360724	·635027	1·574735	·8441720	35	45	·5409745	·643221	1·554674	·8410390	15
5	·5311521	·626893	1·595167	·8472765	55	26	·5363179	·635435	1·573723	·8440161	34	46	·5412191	·643632	1·553680	·8408816	14
6	·5313986	·627298	1·594136	·8471219	54	27	·5365634	·635844	1·572712	·8438600	33	47	·5414637	·644044	1·552688	·8407241	13
7	·5316450	·627704	1·593107	·8469673	53	28	·5368089	·636252	1·571702	·8437039	32	48	·5417082	·644456	1·551696	·8405666	12
8	·5318913	·628109	1·592078	·8468126	52	29	·5370543	·636661	1·570693	·8435477	31	49	·5419527	·644867	1·550705	·8404090	11
9	·5321376	·628515	1·591050	·8466579	51	30	·5372996	·637070	1·569685	·8433914	30	50	·5421971	·645279	1·549715	·8402513	10
10	·5323839	·628921	1·590023	·8465030	50	31	·5375449	·637479	1·568678	·8432351	29	51	·5424415	·645691	1·548726	·8400936	9
11	·5326301	·629327	1·588997	·8463481	49	32	·5377902	·637888	1·567672	·8430787	28	52	·5426859	·646104	1·547738	·8399357	8
12	·5328763	·629733	1·587973	·8461932	48	33	·5380354	·638297	1·566666	·8429222	27	53	·5429302	·646516	1·546751	·8397778	7
13	·5331224	·630139	1·586949	·8460381	47	34	·5382806	·638707	1·565662	·8427657	26	54	·5431744	·646929	1·545764	·8396199	6
14	·5333685	·630546	1·585926	·8458830	46	35	·5385257	·639116	1·564659	·8426091	25	55	·5434187	·647341	1·544779	·8394618	5
15	·5336145	·630953	1·584904	·8457278	45	36	·5387708	·639526	1·563656	·8424524	24	56	·5436628	·647754	1·543794	·8393037	4
16	·5338605	·631359	1·583883	·8455726	44	37	·5390158	·639936	1·562654	·8422956	23	57	·5439069	·648167	1·542810	·8391455	3
17	·5341065	·631766	1·582862	·8454172	43	38	·5392608	·640346	1·561654	·8421388	22	58	·5441510	·648580	1·541828	·8389873	2
18	·5343523	·632173	1·581843	·8452618	42	39	·5395058	·640756	1·560654	·8419819	21	59	·5443951	·648994	1·540846	·8388290	1
19	·5345982	·632581	1·580825	·8451064	41	40	·5397507	·641167	1·559655	·8418249	20	60	·5446390	·649407	1·539865	·8386706	0
20	·5348440	·632988	1·579807	·8449508	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 57. Deg. 57. Deg. 57

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

33 Deg. 33 Deg. 33 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5446390	·649407	1·539865	·8386706	60	21	·5497520	·658127	1·519463	·8353279	39	41	·5546024	·666496	1·500382	·8321155	19
1	·5448830	·649821	1·538884	·8385121	59	22	·5499950	·658544	1·518501	·8351680	38	42	·5548444	·666917	1·499436	·8319541	18
2	·5451269	·650235	1·537905	·8383536	58	23	·5502379	·658961	1·517540	·8350080	37	43	·5550864	·667337	1·498492	·8317927	17
3	·5453707	·650649	1·536927	·8381950	57	24	·5504807	·659378	1·516579	·8348479	36	44	·5553283	·667758	1·497548	·8316312	16
4	·5456145	·651063	1·535949	·8380363	56	25	·5507236	·659796	1·515620	·8346877	35	45	·5555702	·668178	1·496605	·8314696	15
5	·5458583	·651477	1·534972	·8378775	55	26	·5509663	·660213	1·514661	·8345275	34	46	·5558121	·668599	1·495663	·8313080	14
6	·5461020	·651891	1·533996	·8377187	54	27	·5512091	·660631	1·513703	·8343672	33	47	·5560539	·669020	1·494722	·8311463	13
7	·5463456	·652306	1·533021	·8375598	53	28	·5514518	·661049	1·512746	·8342068	32	48	·5562956	·669441	1·493782	·8309845	12
8	·5465892	·652721	1·532047	·8374009	52	29	·5516944	·661467	1·511790	·8340463	31	49	·5565373	·669863	1·492842	·8308226	11
9	·5468328	·653136	1·531074	·8372418	51	30	·5519370	·661885	1·510835	·8338858	30	50	·5567790	·670284	1·491903	·8306607	10
10	·5470763	·653551	1·530102	·8370827	50	31	·5521795	·662304	1·509880	·8337252	29	51	·5570206	·670706	1·490965	·8304987	9
11	·5473198	·653966	1·529130	·8369236	49	32	·5524220	·662722	1·508927	·8335646	28	52	·5572621	·671128	1·490028	·8303366	8
12	·5475632	·654381	1·528160	·8367643	48	33	·5526645	·663141	1·507974	·8334038	27	53	·5575036	·671550	1·489092	·8301745	7
13	·5478066	·654797	1·527190	·8366050	47	34	·5529069	·663560	1·507022	·8332430	26	54	·5577451	·671972	1·488157	·8300123	6
14	·5480499	·655212	1·526221	·8364456	46	35	·5531492	·663979	1·506071	·8330822	25	55	·5579865	·672394	1·487222	·8298500	5
15	·5482932	·655628	1·525253	·8362862	45	36	·5533915	·664398	1·505121	·8329212	24	56	·5582279	·672816	1·486288	·8296877	4
16	·5485365	·656044	1·524286	·8361266	44	37	·5536338	·664817	1·504171	·8327602	23	57	·5584692	·673239	1·485355	·8295252	3
17	·5487797	·656460	1·523320	·8359670	43	38	·5538760	·665237	1·503222	·8325991	22	58	·5587105	·673662	1·484423	·8293628	2
18	·5490228	·656877	1·522354	·8358074	42	39	·5541182	·665657	1·502275	·8324380	21	59	·5589517	·674085	1·483491	·8292002	1
19	·5492659	·657293	1·521389	·8356476	41	40	·5543603	·666076	1·501328	·8322768	20	60	·5591929	·674508	1·482561	·8290376	0
20	·5495090	·657710	1·520426	·8354878	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 56. Deg. 56. Deg. 56.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

34 Deg. **34 Deg.** **34 Deg.**

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5591929	·674508	1·482561	·8290376	60	21	·5642467	·683433	1·463200	·8256062	39	41	·5690403	·692002	1·445081	·8223096	19
1	·5594340	·674931	1·481631	·2288749	59	22	·5644869	·683860	1·462287	·8254420	38	42	·5692795	·692432	1·444183	·8221440	18
2	·5596751	·675355	1·480702	·8287121	58	23	·5647270	·684287	1·461374	·8252778	37	43	·5695187	·692863	1·443286	·8219784	17
3	·5599162	·675779	1·479773	·8285493	57	24	·5649670	·684714	1·460463	·8251135	36	44	·5697577	·693293	1·442389	·8218127	16
4	·5601572	·676202	1·478846	·8283864	56	25	·5652070	·685141	1·459552	·8249491	35	45	·5699968	·693724	1·441494	·8216469	15
5	·5603981	·676626	1·477919	·8282234	55	26	·5654469	·685569	1·458642	·8247847	34	46	·5702357	·694155	1·440599	·8214811	14
6	·5606390	·677050	1·476993	·8280603	54	27	·5656868	·685996	1·457732	·8246202	33	47	·5704747	·694586	1·439704	·8213152	13
7	·5608798	·677475	1·476068	·8278972	53	28	·5659267	·686424	1·456824	·8244556	32	48	·5707136	·695018	1·438811	·8211492	12
8	·5611206	·677899	1·475144	·8277340	52	29	·5661665	·686852	1·455916	·8242909	31	49	·5709524	·695449	1·437918	·8209832	11
9	·5613614	·678324	1·474221	·8275708	51	30	·5664062	·687281	1·455009	·8241262	30	50	·5711912	·695881	1·437026	·8208170	10
10	·5616021	·678749	1·473298	·8274074	50	31	·5666459	·687709	1·454102	·8239614	29	51	·5714299	·696313	1·436135	·8206509	9
11	·5618428	·679174	1·472376	·8272440	49	32	·5668856	·688137	1·453197	·8237965	28	52	·5716686	·696745	1·435245	·8204846	8
12	·5620834	·679599	1·471455	·8270806	48	33	·5671252	·688566	1·452292	·8236316	27	53	·5719073	·697177	1·434355	·8203183	7
13	·5623239	·680024	1·470535	·8269170	47	34	·5673648	·688995	1·451388	·8234666	26	54	·5721459	·697609	1·433466	·8201519	6
14	·5625645	·680450	1·469615	·8267534	46	35	·5676043	·689424	1·450485	·8233015	25	55	·5723844	·698042	1·432578	·8199854	5
15	·5628049	·680875	1·468696	·8265897	45	36	·5678437	·689853	1·449582	·8231364	24	56	·5726229	·698474	1·431690	·8198189	4
16	·5630453	·681301	1·467778	·8264260	44	37	·5680832	·690283	1·448680	·8229712	23	57	·5728614	·698907	1·430803	·8196523	3
17	·5632857	·681727	1·466861	·8262622	43	38	·5683225	·690712	1·447779	·8228059	22	58	·5730998	·699340	1·429917	·8194856	2
18	·5635260	·682153	1·465945	·8260983	42	39	·5685619	·691142	1·446879	·8226405	21	59	·5733381	·699774	1·429032	·8193189	1
19	·5637663	·682580	1·465029	·8259343	41	40	·5688011	·691572	1·445980	·8224751	20	60	·5735764	·700207	1·428148	·8191520	0
20	·5640066	·683006	1·464114	·8257703	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 55. **Deg. 55.** **Deg. 55.**

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

35 Deg. 35 Deg. 35 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5735764	·700207	1·428148	·8191520	60	21	·5785696	·709350	1·409740	·8156330	39	41	·5833050	·718131	1·392501	·8122532	19
1	·5738147	·700641	1·427264	·8189852	59	22	·5788069	·709787	1·408871	·8154647	38	42	·5835412	·718572	1·391647	·8120835	18
2	·5740529	·701074	1·426381	·8188182	58	23	·5790440	·710225	1·408003	·8152963	37	43	·5837774	·719014	1·390793	·8119137	17
3	·5742911	·701508	1·425498	·8186512	57	24	·5792812	·710663	1·407136	·8151278	36	44	·5840136	·719455	1·389940	·8117439	16
4	·5745292	·701943	1·424617	·8184841	56	25	·5795183	·711100	1·406270	·8149593	35	45	·5842497	·719897	1·389087	·8115740	15
5	·5747672	·702377	1·423736	·8183169	55	26	·5797553	·711539	1·405404	·8147906	34	46	·5844857	·720338	1·388235	·8114040	14
6	·5750053	·702811	1·422856	·8181497	54	27	·5799923	·711977	1·404539	·8146220	33	47	·5847217	·720780	1·387384	·8112339	13
7	·5752432	·703246	1·421976	·8179824	53	28	·5802292	·712415	1·403674	·8144532	32	48	·5849577	·721222	1·386534	·8110638	12
8	·5154811	·703681	1·421097	·8178151	52	29	·5804661	·712854	1·402811	·8142844	31	49	·5851936	·721665	1·385684	·8108936	11
9	·5757190	·704116	1·420220	·8176476	51	30	·5807030	·713293	1·401948	·8141155	30	50	·5854294	·722107	1·384835	·8107234	10
10	·5759568	·704551	1·419342	·8174801	50	31	·5809397	·713732	1·401086	·8139466	29	51	·5856652	·722550	1·383986	·8105530	9
11	·5761946	·704986	1·418466	·8173125	49	32	·5811765	·714171	1·400224	·8137775	28	52	·5859010	·722993	1·383139	·8103826	8
12	·5764323	·705422	1·417590	·8171449	48	33	·5814132	·714610	1·399363	·8136084	27	53	·5861367	·723436	1·382292	·8102122	7
13	·5766700	·705858	1·416715	·8169772	47	34	·5816498	·715050	1·398503	·8134393	26	54	·5863724	·723879	1·381445	·8100416	6
14	·5769076	·706294	1·415840	·8168094	46	35	·5818864	·715489	1·397644	·8132701	25	55	·5866080	·724322	1·380600	·8098710	5
15	·5771452	·706730	1·414967	·8166416	45	36	·5821230	·715929	1·396785	·8131008	24	56	·5868435	·724766	1·379755	·8097004	4
16	·5773827	·707166	1·414094	·8164736	44	37	·5823595	·716369	1·395927	·8129314	23	57	·5870790	·725210	1·378910	·8095296	3
17	·5776202	·707602	1·413222	·8163056	43	38	·5825959	·716810	1·395069	·8127620	22	58	·5873145	·725654	1·378067	·8093588	2
18	·5778576	·708039	1·412350	·8161376	42	39	·5828323	·717250	1·394213	·8125925	21	59	·5875499	·726098	1·377224	·8091879	1
19	·5780950	·708476	1·411479	·8159695	41	40	·5830687	·717691	1·393357	·8124229	20	60	·5877853	·726542	1·376381	·8090170	0
20	·5783323	·708913	1·410609	·8158013	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 54. Deg. 54. Deg. 54.

IV.—Natural Sines and Tangents to a Radius 1—*continued.*

36 Deg. 36 Deg. 36 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·5877853	·726542	1·376381	·8090170	60	21	·5927163	·735917	1·358848	·8054113	39	41	·5973919	·744924	1·342417	·8019495	19
1	·5880206	·726987	1·375540	·8088460	59	22	·5929505	·736366	1·358020	·8052389	38	42	·5976251	·745377	1·341602	·8017756	18
2	·5882558	·727431	1·374699	·8086749	58	23	·5931847	·736814	1·357193	·8050664	37	43	·5978583	·745829	1·340788	·8016018	17
3	·5884910	·727876	1·373859	·8085037	57	24	·5934189	·737263	1·356367	·8048938	36	44	·5980915	·746282	1·339975	·8014278	16
4	·5887262	·728321	1·373019	·8083325	56	25	·5936530	·737712	1·355541	·8047211	35	45	·5983246	·746735	1·339162	·8012538	15
5	·5889613	·728767	1·372180	·8081612	55	26	·5938871	·738162	1·354716	·8045484	34	46	·5985577	·747188	1·338350	·8010797	14
6	·5891964	·729212	1·371342	·8079899	54	27	·5941211	·738611	1·353891	·8043756	33	47	·5987906	·747642	1·337538	·8009056	13
7	·5894314	·729658	1·370504	·8078185	53	28	·5943550	·739061	1·353068	·8042028	32	48	·5990236	·748095	1·336727	·8007314	12
8	·5896663	·730104	1·369667	·8076470	52	29	·5945889	·739511	1·352244	·8040299	31	49	·5992565	·748549	1·335917	·8005571	11
9	·5899012	·730550	1·368831	·8074754	51	30	·5948228	·739961	1·351422	·8038569	30	50	·5994893	·749003	1·335107	·8003827	10
10	·5901361	·730996	1·367995	·8073038	50	31	·5950566	·740411	1·350600	·8036838	29	51	·5997221	·749457	1·334298	·8002083	9
11	·5903709	·731442	1·367161	·8071321	49	32	·5952904	·740861	1·349779	·8035107	28	52	·5999549	·749911	1·333490	·8000338	8
12	·5906057	·731889	1·366326	·8069603	48	33	·5955241	·741312	1·348958	·8033375	27	53	·6001876	·750366	1·332682	·7998593	7
13	·5908404	·732336	1·365493	·8067885	47	34	·5957577	·741763	1·348139	·8031642	26	54	·6004202	·750821	1·331875	·7996847	6
14	·5910750	·732783	1·364660	·8066166	46	35	·5959913	·742214	1·347319	·8029909	25	55	·6006528	·751276	1·331068	·7995100	5
15	·5913096	·733230	1·363827	·8064446	45	36	·5962249	·742665	1·346501	·8028175	24	56	·6008854	·751731	1·330262	·7993352	4
16	·5915442	·733677	1·362996	·8062726	44	37	·5964584	·743117	1·345683	·8026440	23	57	·6011179	·752186	1·329457	·7991604	3
17	·5917787	·734125	1·362165	·8061005	43	38	·5966918	·743568	1·344865	·8024705	22	58	·6013503	·752642	1·328652	·7989855	2
18	·5920132	·734573	1·361335	·8059283	42	39	·5969252	·744020	1·344049	·8022969	21	59	·6015827	·753098	1·327848	·7988105	1
19	·5922476	·735021	1·360505	·8057560	41	40	·5971586	·744472	1·343233	·8021232	20	60	·6018150	·753554	1·327044	·7986355	0
20	·5924819	·735469	1·359676	·8055837	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.		′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 53. Deg. 53. Deg. 53.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

37 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6018150	·753554	1·327044	·7986355	60
1	·6020473	·754010	1·326242	·7984604	59
2	·6022795	·754466	1·325439	·7982853	58
3	·6025117	·754923	1·324638	·7981100	57
4	·6027439	·755379	1·323837	·7979347	56
5	·6029760	·755836	1·323036	·7977594	55
6	·6032080	·756294	1·322237	·7975839	54
7	·6034400	·756751	1·321437	·7974084	53
8	·6036719	·757209	1·320639	·7972329	52
9	·6039038	·757666	1·319841	·7970572	51
10	·6041356	·758124	1·319044	·7968815	50
11	·6043674	·758582	1·318247	·7967058	49
12	·6045991	·759041	1·317451	·7965299	48
13	·6048308	·759499	1·316655	·7963540	47
14	·6050624	·759958	1·315861	·7961780	46
15	·6052940	·760417	1·315066	·7960020	45
16	·6055255	·760876	1·314273	·7958259	44
17	·6057570	·761336	1·313480	·7956497	43
18	·6059884	·761795	1·312687	·7954735	42
19	·6062198	·762255	1·311895	·7952972	41
20	·6064511	·762715	1·311104	·7951208	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 52.

37 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·6066824	·763175	1·310314	·7949444	39
22	·6069136	·763636	1·309523	·7947678	38
23	·6071447	·764096	1·308734	·7945913	37
24	·6073758	·764557	1·307945	·7944146	36
25	·6076069	·765018	1·307157	·7942379	35
26	·6078379	·765480	1·306369	·7940611	34
27	·6080689	·765941	1·305582	·7938843	33
28	·6082998	·766403	1·304796	·7937074	32
29	·6085306	·766864	1·304010	·7935304	31
30	·6087614	·767327	1·303225	·7933533	30
31	·6089922	·767789	1·302440	·7931762	29
32	·6092229	·768251	1·301656	·7929990	28
33	·6094535	·768714	1·300873	·7928218	27
34	·6096841	·769177	1·300090	·7926445	26
35	·6099147	·769640	1·299308	·7924671	25
36	·6101452	·770103	1·298526	·7922896	24
37	·6103756	·770567	1·297745	·7921121	23
38	·6106060	·771030	1·296964	·7919345	22
39	·6108363	·771494	1·296185	·7917569	21
40	·6110666	·771958	1·295405	·7915792	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 52.

37 Deg.

	Sine.	Tang.	Cotang.	Cosine.	′
41	·6112969	·772423	1·294627	·7914014	19
42	·6115270	·772887	1·293848	·7912235	18
43	·6117572	·773352	1·293071	·7910456	17
44	·6119873	·773817	1·292294	·7908676	16
45	·6122173	·774282	1·291517	·7906896	15
46	·6124473	·774748	1·290742	·7905115	14
47	·6126772	·775213	1·289966	·7903333	13
48	·6129071	·776679	1·289192	·7901550	12
49	·6131369	·776145	1·288418	·7899767	11
50	·6133666	·776611	1·287644	·7897983	10
51	·6135964	·777078	1·286871	·7896198	9
52	·6138260	·777544	1·286099	·7894413	8
53	·6140556	·778011	1·285327	·7892627	7
54	·6142852	·778478	1·284556	·7890841	6
55	·6145147	·778946	1·283786	·7889054	5
56	·6147442	·779413	1·283016	·7887266	4
57	·6149736	·779881	1·282246	·7885477	3
58	·6152029	·780349	1·281477	·7883688	2
59	·6154322	·780817	1·280709	·7881898	1
60	·6156615	·781285	1·279941	·7880108	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 52.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

38 Deg. 38 Deg. 38 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6156615	·781285	1·279941	·7880108	60	21	·6204636	·791170	1·263950	·7842352	39	41	·6250156	·800673	1·248948	·7806123	19
1	·6158907	·781754	1·279174	·7878316	59	22	·6206917	·791643	1·263195	·7840547	38	42	·6252427	·801151	1·248204	·7804304	18
2	·6161198	·782222	1·278407	·7876524	58	23	·6209198	·792116	1·262440	·7838741	37	43	·6254696	·801628	1·247460	·7802485	17
3	·6163489	·782691	1·277641	·7874732	57	24	·6211478	·792590	1·261686	·7836935	36	44	·6256966	·802106	1·246716	·7800665	16
4	·6165780	·783161	1·276876	·7872939	56	25	·6213757	·793064	1·260932	·7835127	35	45	·6259235	·802584	1·245974	·7798845	15
5	·6168069	·783630	1·276111	·7871145	55	26	·6216036	·793537	1·260179	·7833320	34	46	·6261503	·803063	1·245232	·7797024	14
6	·6170359	·784100	1·275347	·7869350	54	27	·6218314	·794012	1·259426	·7831511	33	47	·6263771	·803541	1·244490	·7795202	13
7	·6172648	·784570	1·274583	·7867555	53	28	·6220592	·794486	1·258674	·7829702	32	48	·6266038	·804020	1·243749	·7793380	12
8	·6174936	·785040	1·273820	·7865759	52	29	·6222870	·794961	1·257923	·7827892	31	49	·6268305	·804499	1·243008	·7791557	11
9	·6177224	·785510	1·273057	·7863963	51	30	·6225146	·795435	1·257172	·7826082	30	50	·6270571	·804979	1·242268	·7789733	10
10	·6179511	·785980	1·272295	·7862165	50	31	·6227423	·795911	1·256421	·7824270	29	51	·6272837	·805458	1·241529	·7787909	9
11	·6181798	·786451	1·271534	·7860367	49	32	·6229698	·796386	1·255672	·7822459	28	52	·6275102	·805938	1·240790	·7786084	8
12	·6184084	·786922	1·270773	·7858569	48	33	·6231974	·796861	1·254922	·7820646	27	53	·6277366	·806418	1·240051	·7784258	7
13	·6186370	·787393	1·270013	·7856770	47	34	·6234248	·797337	1·254174	·7818833	26	54	·6279631	·806898	1·239313	·7782431	6
14	·6188655	·787864	1·269253	·7854970	46	35	·6236522	·797813	1·253426	·7817019	25	55	·6281894	·807378	1·238576	·7780604	5
15	·6190939	·788336	1·268494	·7853169	45	36	·6238796	·798289	1·252678	·7815205	24	56	·6284157	·807859	1·237839	·7778777	4
16	·6193224	·788808	1·267735	·7851368	44	37	·6241069	·798765	1·251931	·7813390	23	57	·6286420	·808340	1·237103	·7776949	3
17	·6195507	·789280	1·266977	·7849566	43	38	·6243342	·799242	1·251184	·7811574	22	58	·6288682	·808821	1·236367	·7775120	2
18	·6197790	·789752	1·266219	·7847764	42	39	·6245614	·799719	1·250438	·7809757	21	59	·6290943	·809302	1·235631	·7773290	1
19	·6200073	·790224	1·265462	·7845961	41	40	·6247885	·800196	1·249693	·7807940	20	60	·6293204	·809784	1·234897	·7771460	0
20	·6202355	·790697	1·264706	·7844157	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 51. Deg. 51. Deg. 51.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

39 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6293204	·809784	1·234897	·7771460	60
1	·6295464	·810265	1·234162	·7769629	59
2	·6297724	·810747	1·233429	·7767797	58
3	·6299983	·811230	1·232696	·7765965	57
4	·6302242	·811712	1·231963	·7764132	56
5	·6304500	·812195	1·231231	·7762298	55
6	·6306758	·812678	1·230499	·7760464	54
7	·6309015	·813161	1·229768	·7758629	53
8	·6311272	·813644	1·229038	·7756794	52
9	·6313528	·814128	1·228308	·7754957	51
10	·6315784	·814611	1·227578	·7753121	50
11	·6318039	·815095	1·226849	·7751283	49
12	·6320293	·815580	1·226121	·7749445	48
13	·6322547	·816064	1·225393	·7747606	47
14	·6324800	·816549	1·224665	·7745767	46
15	·6327053	·817034	1·223938	·7743926	45
16	·6329306	·817519	1·223212	·7742086	44
17	·6331557	·818004	1·222486	·7740244	43
18	·6333809	·818490	1·221761	·7738402	42
19	·6336059	·818976	1·221036	·7736559	41
20	·6338310	·819462	1·220312	·7734716	40
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 50.

39 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
21	·6340559	·819948	1·219588	·7732872	39
22	·6342808	·820435	1·218865	·7731027	38
23	·6345057	·820922	1·218142	·7729182	37
24	·6347305	·821409	1·217419	·7727336	36
25	·6349553	·821896	1·216698	·7725489	35
26	·6351800	·822384	1·215976	·7723642	34
27	·6354046	·822871	1·215256	·7721794	33
28	·6356292	·823359	1·214535	·7719945	32
29	·6358537	·823847	1·213816	·7718096	31
30	·6360782	·824336	1·213097	·7716246	30
31	·6363026	·824825	1·212378	·7714395	29
32	·6365270	·825314	1·211660	·7712544	28
33	·6367513	·825803	1·210942	·7710692	27
34	·6369756	·826292	1·210225	·7708840	26
35	·6371998	·826782	1·209508	·7706986	25
36	·6374240	·827271	1·208792	·7705132	24
37	·6376481	·827762	1·208076	·7703278	23
38	·6378721	·828252	1·207361	·7701423	22
39	·6380961	·828742	1·206646	·7699567	21
40	·6383201	·829233	1·205932	·7697710	20
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 50.

39 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′
41	·6385440	·829724	1·205219	·7695853	19
42	·6387678	·830216	1·204505	·7693996	18
43	·6389916	·830707	1·203793	·7692137	17
44	·6392153	·831199	1·203081	·7690278	16
45	·6394390	·831691	1·202369	·7688418	15
46	·6396626	·832183	1·201658	·7686558	14
47	·6398862	·832675	1·200947	·7684697	13
48	·6401097	·833168	1·200237	·7682835	12
49	·6403332	·833661	1·199527	·7680973	11
50	·6405566	·834154	1·198818	·7679110	10
51	·6407799	·834648	1·198109	·7677246	9
52	·6410032	·835141	1·197401	·7675382	8
53	·6412264	·835635	1·196693	·7673517	7
54	·6414496	·836129	1·195986	·7671652	6
55	·6416728	·836624	1·195279	·7669785	5
56	·6418958	·837118	1·194573	·7667918	4
57	·6421189	·837613	1·193867	·7666051	3
58	·6423418	·838108	1·193162	·7664183	2
59	·6425647	·838604	1·192457	·7662314	1
60	·6427876	·839099	1·191753	·7660444	0
′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 50.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

40 Deg. 40 Deg. 40 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6427876	·839099	1·191753	·7660444	60	21	·6474551	·849563	1·177075	·7621036	39	41	·6518778	·859629	1·163291	·7583240	19
1	·6430104	·839595	1·191049	·7658574	59	22	·6476767	·850064	1·176382	·7619152	38	42	·6520984	·860135	1·162607	·7581343	18
2	·6432332	·840091	1·190346	·7656704	58	23	·6478984	·850565	1·175688	·7617268	37	43	·6523189	·860641	1·161923	·7579446	17
3	·6434559	·840587	1·189643	·7654832	57	24	·6481199	·851066	1·174996	·7615383	36	44	·6525394	·861148	1·161240	·7577548	16
4	·6436785	·841084	1·188941	·7652960	56	25	·6483414	·851568	1·174303	·7613497	35	45	·6527598	·861655	1·160557	·7575650	15
5	·6439011	·841581	1·188239	·7651087	55	26	·6485628	·852070	1·173612	·7611611	34	46	·6529801	·862162	1·159874	·7573751	14
6	·6441236	·842078	1·187538	·7649214	54	27	·6487842	·852572	1·172920	·7609724	33	47	·6532004	·862669	1·159192	·7571851	13
7	·6443461	·842575	1·186837	·7647340	53	28	·6490056	·853075	1·172229	·7607837	32	48	·6534206	·863176	1·158511	·7569951	12
8	·6445685	·843073	1·186136	·7645465	52	29	·6492268	·853577	1·171539	·7605949	31	49	·6536408	·863684	1·157830	·7568050	11
9	·6447909	·843570	1·185437	·7643590	51	30	·6494480	·854080	1·170849	·7604060	30	50	·6538609	·864192	1·157149	·7566148	10
10	·6450132	·844068	1·184737	·7641714	50	31	·6496692	·854583	1·170160	·7602170	29	51	·6540810	·864700	1·156469	·7564246	9
11	·6452355	·844567	1·184038	·7639838	49	32	·6498903	·855087	1·169471	·7600280	28	52	·6543010	·865209	1·155789	·7562343	8
12	·6454577	·845065	1·183340	·7637960	48	33	·6501114	·855591	1·168782	·7598389	27	53	·6545209	·865718	1·155110	·7560439	7
13	·6456798	·845564	1·182642	·7636082	47	34	·6503324	·856095	1·168094	·7596498	26	54	·6547408	·866227	1·154431	·7558535	6
14	·6459019	·846063	1·181944	·7634204	46	35	·6505533	·856599	1·167407	·7594606	25	55	·6549607	·866736	1·153753	·7556630	5
15	·6461240	·846562	1·181247	·7632325	45	36	·6507742	·857103	1·166720	·7592713	24	56	·6551804	·867246	1·153075	·7554724	4
16	·6463460	·847062	1·180551	·7630445	44	37	·6509951	·857608	1·166033	·7590820	23	57	·6554002	·867755	1·152397	·7552818	3
17	·6465679	·847561	1·179855	·7628564	43	38	·6512158	·858113	1·165347	·7588926	22	58	·6556198	·868265	1·151721	·7550911	2
18	·6467898	·848061	1·179159	·7626683	42	39	·6514366	·858618	1·164661	·7587031	21	59	·6558395	·868776	1·151044	·7549004	1
19	·6470116	·848561	1·178464	·7624802	41	40	·6516572	·859124	1·163976	·7585136	20	60	·6560590	·869286	1·150368	·7547096	0
20	·6472334	·849062	1·177769	·7622919	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 49. Deg. 49. Deg. 49.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

41 Deg. 41 Deg. 41 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6560590	·869286	1·150368	·3547096	60	21	·6606570	·880068	1·136274	·7506879	39	41	·6650131	·890445	1·123032	·7468317	19
1	·6562785	·869797	1·149692	·7545187	59	22	·6608754	·880585	1·135608	·7504957	38	42	·6652304	·890967	1·122375	·7466382	18
2	·6564980	·870308	1·149017	·7543278	58	23	·6610936	·881101	1·134942	·7503034	37	43	·6654475	·891489	1·121718	·7464446	17
3	·6567174	·870820	1·148342	·7541368	57	24	·6613119	·881618	1·134277	·7501111	36	44	·6656646	·892011	1·121061	·7462510	16
4	·6569367	·871331	1·147668	·7539457	56	25	·6615300	·882135	1·133612	·7499187	35	45	·6658817	·892534	1·120405	·7460574	15
5	·6571560	·871843	1·146994	·7537546	55	26	·6617482	·882653	1·132947	·7497262	34	46	·6660987	·893056	1·119749	·7458638	14
6	·6573752	·872355	1·146321	·7535634	54	27	·6619662	·883170	1·132283	·7495337	33	47	·6663156	·893579	1·119094	·7456699	13
7	·6575944	·872868	1·145648	·7533721	53	28	·6621842	·883688	1·131620	·7493411	32	48	·6665325	·894103	1·118439	·7454760	12
8	·6578135	·873380	1·144976	·7531808	52	29	·6624022	·884206	1·130957	·7491484	31	49	·6667493	·894626	1·117784	·7452821	11
9	·6580326	·873893	1·144304	·7529894	51	30	·6626200	·884725	1·130294	·7489557	30	50	·6669661	·895150	1·117130	·7450881	10
10	·6582516	·874406	1·143632	·7527980	50	31	·6628379	·885244	1·129632	·7487629	29	51	·6671828	·895674	1·116476	·7448941	9
11	·6584706	·874920	1·142961	·7526065	49	32	·6630557	·885763	1·128970	·7485701	28	52	·6673994	·896199	1·115823	·7446999	8
12	·6586895	·875433	1·142290	·7524149	48	33	·6632734	·886282	1·128308	·7483772	27	53	·6676160	·896723	1·115170	·7445058	7
13	·6589083	·875947	1·141620	·7522233	47	34	·6634910	·886801	1·127647	·7481842	26	54	·6678326	·897248	1·114518	·7443115	6
14	·6591271	·876462	1·140950	·7520316	46	35	·6637087	·887321	1·126987	·7479912	25	55	·6680490	·897773	1·113866	·7441173	5
15	·6593458	·876976	1·140281	·7518398	45	36	·6639262	·887841	1·126327	·7477981	24	56	·6682655	·898299	1·113214	·7439229	4
16	·6595645	·877491	1·139612	·7516480	44	37	·6641437	·888361	1·125667	·7476049	23	57	·6684818	·898825	1·112563	·7437285	3
17	·6597831	·878006	1·138944	·7514561	43	38	·6643612	·888882	1·125008	·7474117	22	58	·6686981	·899351	1·111912	·7435340	2
18	·6600017	·878521	1·138276	·7512641	42	39	·6645785	·889403	1·124349	·7472184	21	59	·6689144	·899877	1·111262	·7433394	1
19	·6602202	·879037	1·137608	·7510721	41	40	·6647959	·889924	1·126690	·7470251	20	60	·6691306	·900404	1·110612	·7431448	0
20	·6604386	·879552	1·136941	·7508800	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 48. Deg. 48. Deg. 48.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

42 Deg. 42 Deg. 42 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6691306	·900404	1·110612	·7431448	60	21	·6736577	·911526	1·097060	·7390435	39	41	·6779459	·922235	1·084322	·7351118	19
1	·6693468	·900930	1·109963	·7429502	59	22	·6738727	·912059	1·096420	·7388475	38	42	·6781597	·922773	1·083689	·7349146	18
2	·6695628	·901458	1·109314	·7427554	58	23	·6740876	·912592	1·095779	·7386515	37	43	·6783734	·923312	1·083057	·7347173	17
3	·6697789	·901985	1·108665	·7425606	57	24	·6743024	·913125	1·095139	·7384553	36	44	·6785871	·923851	1·082425	·7345199	16
4	·6699948	·902513	1·108017	·7423658	56	25	·6745172	·913659	1·094500	·7382592	35	45	·6788007	·924390	1·081793	·7343225	15
5	·6702108	·903041	1·107369	·7421708	55	26	·6747319	·914192	1·093861	·7380629	34	46	·6790143	·924930	1·081162	·7341250	14
6	·6704266	·903569	1·106721	·7419758	54	27	·6749466	·914727	1·093222	·7378666	33	47	·6792278	·925470	1·080532	·7339275	13
7	·6706424	·904097	1·106075	·7417808	53	28	·6751612	·915261	1·092584	·7376703	32	48	·6794413	·926010	1·079901	·7337299	12
8	·6708582	·904626	1·105428	·7415857	52	29	·6753757	·915796	1·091946	·7374738	31	49	·6796547	·926550	1·079271	·7335322	11
9	·6710739	·905155	1·104782	·7413905	51	30	·6755902	·916331	1·091308	·7372773	30	50	·6798681	·927091	1·078642	·7333345	10
10	·6712895	·905685	1·104136	·7411953	50	31	·6758046	·916866	1·090671	·7370808	29	51	·6800813	·927632	1·078013	·7331367	9
11	·8715051	·906214	1·103491	·7410000	49	32	·6760190	·917402	1·090034	·7368842	28	52	·6802946	·928173	1·077384	·7329388	8
12	·6717206	·906744	1·102846	·7408046	48	33	·6762333	·917937	1·089398	·7366875	27	53	·6805078	·928715	1·076756	·7327409	7
13	·6719361	·907274	1·102201	·7406092	47	34	·6764476	·918474	1·088762	·7364908	26	54	·6807209	·929257	1·076128	·7325429	6
14	·6721515	·907805	1·101557	·7404137	46	35	·6766618	·919010	1·088126	·7362940	25	55	·6809339	·929799	1·075500	·7323449	5
15	·6723668	·908336	1·100914	·7402181	45	36	·6768760	·919547	1·087491	·7360971	24	56	·6811469	·930342	1·074873	·7321467	4
16	·6725821	·908867	1·100270	·7400225	44	37	·6770901	·920084	1·086857	·7359002	23	57	·6813599	·930884	1·074246	·7319486	3
17	·6727973	·909398	1·199628	·7398268	43	38	·6773041	·920621	1·086222	·7357032	22	58	·6815728	·931428	1·073620	·7317503	2
18	·6730125	·909930	1·198985	·7396311	42	39	·6775181	·921159	1·085588	·7355061	21	59	·6817856	·931971	1·072994	·7315521	1
19	·6732276	·910461	1·198343	·7394353	41	40	·6777320	·921696	1·084955	·7353090	20	60	·6819984	·932515	1·072368	·7313537	0
20	·6734427	·910994	1·197702	·7392394	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 47. Deg. 47. Deg 47.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

43 Deg 43 Deg. 43 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6819984	·932515	1·072368	·7313537	60	21	·6864532	·944001	1·059320	·7271740	39	41	·6906721	·955064	1·047049	·7231681	19
1	·6822111	·933059	1·071743	·7311553	59	22	·6866647	·944551	1·058703	·7269743	38	42	·6908824	·955620	1·046440	·7229671	18
2	·6824237	·933603	1·071118	·7309568	58	23	·6868761	·945102	1·058086	·7267745	37	43	·6910927	·956177	1·045831	·7227661	17
3	·6826363	·934147	1·070494	·7307583	57	24	·6870875	·945653	1·057470	·7265747	36	44	·6913029	·956734	1·045222	·7225651	16
4	·6828489	·934692	1·069870	·7305597	56	25	·6872988	·946204	1·056854	·7263748	35	45	·6915131	·957291	1·044613	·7223640	15
5	·6830613	·935238	1·069246	·7303610	55	26	·6875101	·946755	1·056238	·7261748	34	46	·6917232	·957849	1·044005	·7221628	14
6	·6832738	·935783	1·068623	·7301623	54	27	·6877213	·947307	1·855623	·7259748	33	47	·6919332	·958407	1·043397	·7219615	13
7	·6834861	·936329	1·068000	·7299635	53	28	·6879325	·947859	1·055008	·7257747	32	48	·6921432	·958965	1·042790	·7217602	12
8	·6836984	·936875	1·067377	·7297646	52	29	·6881435	·948411	1·054394	·7255746	31	49	·6923531	·959524	1·042183	·7215589	11
9	·6839107	·937421	1·066755	·7295657	51	30	·6883546	·948964	1·053780	·7253744	30	50	·6925630	·960082	1·041576	·7213574	10
10	·6841229	·937968	1·066134	·7293668	50	31	·6885655	·949517	1·053166	·7251741	29	51	·6927728	·960642	1·040970	·7211559	9
11	·6843350	·938515	1·065512	·7291677	49	32	·6887765	·950070	1·052553	·7249738	28	52	·6929825	·961201	1·040364	·7209544	8
12	·6845471	·939062	1·064891	·7289686	48	33	·6889873	·950624	1·051940	·7247734	27	53	·6931922	·961761	1·039758	·7207528	7
13	·6847591	·939610	1·064271	·7287695	47	34	·6891981	·951178	1·051327	·7245729	26	54	·6934018	·962321	1·039153	·7205511	6
14	·6849711	·940157	1·063651	·7285703	46	35	·6894089	·951732	1·050715	·7243724	25	55	·6936114	·962881	1·038548	·7203494	5
15	·6851830	·940706	1·063031	·7283710	45	36	·6896195	·952287	1·050103	·7241719	24	56	·6938209	·963442	1·037944	·7201476	4
16	·6853948	·941254	1·062411	·7281716	44	37	·6898302	·952842	1·049492	·7239712	23	57	·6940304	·964003	1·037340	·7199457	3
17	·6856066	·941803	1·061792	·7279722	43	38	·6900407	·953397	1·048880	·7237705	22	58	·6942398	·964565	1·036736	·7197438	2
18	·6858184	·942352	1·061174	·7277728	42	39	·6902512	·953952	1·048270	·7235698	21	59	·6944491	·965126	1·036133	·7195418	1
19	·6860300	·942901	1·060556	·7275732	41	40	·6904617	·954508	1·047659	·7233690	20	60	·6946584	·965688	1·035530	·7193398	0
20	·8662416	·943451	1·059938	·7273736	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 46. Deg. 46. Deg. 46.

IV.—NATURAL SINES AND TANGENTS TO A RADIUS 1—*continued.*

44 Deg. 44 Deg. 44 Deg.

′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′	′	Sine.	Tang.	Cotang.	Cosine.	′
0	·6946584	·965688	1·035530	·7193398	60	21	·6990396	·977564	1·022950	·7150830	39	41	·7031879	·989006	1·011115	·7110041	19
1	·6948676	·966251	1·034927	·7191377	59	22	·6992476	·978133	1·022355	·7148796	38	42	·7033947	·989582	1·010527	·7107995	18
2	·6950767	·966813	1·034325	·7189355	58	23	·6994555	·978702	1·021760	·7146762	37	43	·7036014	·990158	1·009939	·7105948	17
3	·6952858	·967376	1·033723	·7187333	57	24	·6996633	·979272	1·021166	·7144727	36	44	·7038081	·990734	1·009352	·7103901	16
4	·6954949	·967939	1·033122	·7185310	56	25	·6998711	·979842	1·020572	·7142691	35	45	·7040147	·991311	1·008764	·7101854	15
5	·6957039	·968503	1·032520	·7183287	55	26	·7000789	·980412	1·019978	·7140655	34	46	·7042213	·991888	1·008178	·7099806	14
6	·6959128	·969067	1·031919	·7181263	54	27	·7002866	·980983	1·019385	·7138618	33	47	·7044278	·992465	1·007591	·7097757	13
7	·6961217	·969631	1·031319	·7179238	53	28	·7004942	·981554	1·018792	·7136581	32	48	·7046342	·993042	1·007005	·7095707	12
8	·6963305	·970196	1·030719	·7177213	52	29	·7007018	·982125	1·018199	·7134543	31	49	·7048406	·993620	1·006420	·7093657	11
9	·6965392	·970761	1·030119	·7175187	51	30	·7009093	·982697	1·017607	·7132504	30	50	·7050469	·994199	1·005834	·7091607	10
10	·6967479	·971326	1·029520	·7173161	50	31	·7011167	·983269	1·017015	·7130465	29	51	·7052532	·994777	1·005249	·7089556	9
11	·6969565	·971891	1·028921	·7171134	49	32	·7013241	·983841	1·016423	·7128426	28	52	·7054594	·995356	1·004665	·7087504	8
12	·6971651	·972457	1·028322	·7169106	48	33	·7015314	·984414	1·015832	·7126385	27	53	·7056655	·995935	1·004080	·7085451	7
13	·6973736	·973023	1·027724	·7167078	47	34	·7017387	·984987	1·015241	·7124344	26	54	·7058716	·996515	1·003496	·7083398	6
14	·6975821	·973590	1·027126	·7165049	46	35	·7019459	·985560	1·014651	·7122303	25	55	·7060776	·997095	1·002913	·7081345	5
15	·6977905	·974156	1·026528	·7163019	45	36	·7021531	·986133	1·014061	·7120260	24	56	·7062835	·997675	1·002329	·7079291	4
16	·6979988	·974724	1·025931	·7160989	44	37	·7023601	·986707	1·013471	·7118218	23	57	·7064894	·998256	1·001746	·7077236	3
17	·6982071	·975291	1·025334	·7158959	43	38	·7025672	·987282	1·012881	·7116174	22	58	·7066953	·998837	1·001164	·7075180	2
18	·6984153	·975859	1·024738	·7156927	42	39	·7027741	·987856	1·012292	·7114130	21	59	·7069011	·999418	1·000581	·7073124	1
19	·6986234	·976427	1·024141	·7154895	41	40	·7029811	·988431	1·011703	·7112086	20	60	·7071068	1·00000	1·000000	·7071068	0
20	·6988315	·976995	1·023546	·7152863	40												
′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′	′	Cosine.	Cotan.	Tang.	Sine.	′

Deg. 45. Deg. 45. Deg. 45.

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